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Nos. 495 to 509

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Nos. 495 to 509

495—Potatoes Every Day	The Women's Institute Branch and Home Economics Service
496—Internal Parasites of Swine	A. A. Kingscote
497—Soil Management and Fertilizer Use	Advisory Fertilizer Board for Ontario
498—Rats and Mice	Reg. H. Ozburn
499—Sheep Husbandry in Ontario	Committee of Staff Members of the Ontario Agricultural College Ontario Veterinary College Kemptville Agricultural School Live Stock Branch of the Ontario Department of Agriculture
500—Swine Husbandry in Ontario	Committee of Staff Members of the Ontario Agricultural College Ontario Veterinary College Live Stock Branch of the Ontario Department of Agriculture
501—Farm Drainage	F. L. Ferguson
502—Table Turnips (Rutabagas)	J. Laughland, C. B. Kelly, J. A. Carpenter, H. W. Goble, J. G. Oughton, E. W. Franklin
503—The Raising of Guinea Pigs, Hamsters, Rats and Mice	A. H. Kennedy
504—Frozen Foods	E. W. Franklin, E. S. Snyder, E. C. Stillwell, J. H. L. Truscott, M. Jean Clarke
505—Common Weeds of Ontario	F. H. Montgomery
506—Horses	Committee of Staff Members of the Animal Husbandry Department Ontario Agricultural College Live Stock Branch, Ontario Department of Agriculture
507—House Plants and Gift Plants	H. Bailey and J. S. Shoemaker
508—Plants Poisonous to Livestock	F. H. Montgomery, J. A. Henderson, R. O. Bibbey
509—Beef Husbandry in Ontario	Committee of Staff Members of the Ontario Agricultural College Ontario Veterinary College Live Stock Branch, Ontario Department of Agriculture

ONTARIO DEPARTMENT OF AGRICULTURE
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BULLETIN 495, MARCH, 1953

POTATOES EVERY DAY

POTATOES EVERY DAY

CONTENTS

Page
Boiled Potatoes 6
Mashed Potatoes 7
Baked Potatoes 8
Fried Potatoes 11
Potato Salads 14
Potato Salad Dressings 18
Potato Soups 19
Scalloped Potatoes 20
Potato Supper Dishes 22
Potato Chips 28

MEASUREMENT ABBREVIATIONS

cup	**c.**
teaspoon	**tsp.**
tablespoon	**tbsp.**
ounce	**oz.**
pound	**lb.**
few grains	**f.g.**

MEASUREMENTS

3 tsp.	**1 tbsp.**
16 tbsp.	**1 c.**
1 c.	**8 oz.**

OVEN TEMPERATURES

Slow oven	**250°-350°**
Moderate oven	**350°-400°**
Hot oven	**400°-450°**
Very hot oven	**450°-550°**

POTATOES EVERY DAY

Serve potatoes every day—for good eating, good health and for economy, too.

Potatoes make the meal—baked and topped with melting butter, fried to a crisp golden brown or served as a cool tempting salad. Any way they are cooked, potatoes are wonderful eating. And, just as important, potatoes are good for us.

No dinner is quite complete without potatoes. This recipe book brings you cooking tips and potato recipes, some old and some new, for your enjoyment.

Potatoes can give us so much in food value that we should serve them at least once every day. Potatoes supply these important food essentials:

- Food energy
- B vitamins—Thiamine and Riboflavin
- Vitamin C
- Iron

FOR ECONOMY

Properly cooked, potatoes are an economical source of food energy, vitamins and minerals all the year round. Budget-wise and thrifty housewives can depend on potatoes day in, day out for the family meals. And potatoes are one of the easiest vegetables to serve in a variety of ways.

ARE POTATOES FATTENING?

The answer is NO! This is good news for anyone counting calories. Potatoes are included in most reducing diets because they are a nutritious food.

One medium-sized potato is not more fattening than:

one slice of bread
or
one large apple
or
one large orange

A potato is about one-third as fattening as one piece of cake or a slice of pie. Beware of adding generous amounts of gravy or butter to the potato on your plate—"It's not the potato that is fattening, it's what you put on it."

WHEN YOU BUY POTATOES

Buy potatoes produced in Ontario—your regular dealer can secure suitable supplies of Ontario potatoes for you. They are available direct from growers and a large number of dealers. Always ask for the Ontario product—they are usually the "best buy."

Ontario potatoes are good potatoes. They are produced by more than sixty-five thousand farmers.

Within the Province an extensive scientific research programme is carried on—aiming at providing top quality at the lowest possible cost.

Ontario potatoes have won high honours. In fact, grand championship awards for the past seventeen international shows have been won thirteen times by Ontario growers.

Always choose Ontario potatoes for your table—they are graded for your protection as required by regulations which are the same for all of Canada. In addition to examination by Federal inspectors, the Province maintains staff and facilities to provide consumers with properly graded produce. These grades are identified as Canada Fancy—Canada No. 1—Canada No. 2—Canada No. 1 large, and Canada No. 1 small.

WHEN YOU STORE POTATOES

Potatoes retain more food value when they are stored under proper conditions. Also the flavour and cooking quality will be maintained for a longer time.

Store potatoes in a cool, dark place with high humidity. The best storage temperature is 38 degrees to 40 degrees Fahrenheit. Higher temperatures cause shriveling if the air is dry, and sprouting if the air is humid. Lower temperatures cause a sweet flavour and less favourable cooking quality. Both daylight and electric light will eventually turn stored potatoes green and bitter.

An unheated basement or a small room insulated from the heated portion of a basement offers the best storage conditions for potatoes in many homes. Regulate the storage temperature, when necessary, by ventilating with cool outside air. Sprinkle water on the floor for humidity. Store the potatoes in crates or small bins raised slightly from the floor to permit air circulation.

WHEN YOU COOK POTATOES

Cook potatoes in their jackets rather than pare them. This saves work for you and protects the food value of the potato. If you pare potatoes, you lose valuable minerals and vitamins. During cooking, the potato skin prevents loss of these nutrients in the cooking water.

The skin slips off a cooked potato in a second so for boiled, mashed, creamed potatoes or for a salad, remember to cook potatoes in their jackets.

You can serve more food value when you follow the rules—

TO PRESERVE FOOD VALUE

DO	DON'T
1. Bake, boil or steam potatoes in their jackets.	**1. Soak potatoes in water before cooking.**
2. Prepare potatoes just before meal-time.	**2. Drown potatoes in a large amount of water in saucepan.**
3. Cook in a small amount of boiling water and cover.	**3. Overcook — this destroys flavour and food value.**
4. Cook just until done, serve immediately.	**4. Let potatoes wait to be eaten — vitamins will disappear.**

• BOILED POTATOES

1. Select uniform-sized potatoes.
2. Scrub thoroughly. Leave skins on to save food value.
3. Start potatoes cooking in boiling water (½″ to 1″ in saucepan). Cover closely.
4. Cook only until tender, drain and shake over heat until potatoes are dry and mealy. Serve immediately.

• CREAMED POTATOES

1 c. scalded milk
2 tbsp. flour
2 tbsp. butter
½ tsp. salt
f.g. pepper
2 c. sliced or diced cooked potatoes

1. Cream flour, fat and seasonings together in a bowl. Add to hot milk. Cook and stir until thick and smooth.
2. Pour sauce over potatoes. Heat.
3. Sprinkle with chopped parsley and serve. Serves 6.

• POTATOES AND CABBAGE IN CHEESE SAUCE

2 c. scalded milk
2 tsp. salt
4 tbsp. flour
4 tbsp. butter
1 c. grated cheese
3 c. diced potatoes
4 c. chopped or shredded cabbage

1. Add vegetables to small quantity boiling water. Cover and cook until tender (15-20 minutes).
2. Cream flour, fat and seasonings together in a bowl. Add to hot milk. Cook and stir until thick and smooth.
3. Add cheese to white sauce, stir until melted.
4. Pour cheese sauce over vegetables and serve. Serves 6.

• MASHED POTATOES

1. Cook potatoes in jackets until tender. Drain. Remove skins.
2. Mash thoroughly. Season with salt and pepper. Add butter and hot milk.
3. Whip potatoes until light and fluffy. Serve hot.

• CHANTILLY POTATOES

3 c. mashed potatoes
½ c. heavy cream, stiffly beaten
½ c. grated cheese

1. Pile mashed potatoes on baking dish.
2. Spread cream over potatoes. Sprinkle with cheese.
3. Bake in slow oven, 325°, until delicately brown. Serves 6.

• DUCHESS POTATOES

3 c. mashed potatoes
2 eggs, beaten

1. Beat eggs into mashed potatoes.
2. Arrange in mounds on greased baking sheet or make a border of potato around cooked roast or fish.
3. Brush with milk. Bake in hot oven, 425°, until brown.
Serves 6.

STUFFED BAKED POTATOES

BAKED POTATOES

BAKED POTATOES

1. Scrub and rinse potatoes of uniform size.
2. Grease skins lightly if a soft skin is desired.
3. Bake at 375°-500° until tender, approximately 60 minutes for medium-sized potatoes.
4. Slit a cross in top of potato, pinch gently to make potato puff up—top with butter.

Note: Potatoes cooked at 425°-500° are usually considered better than those cooked at a lower temperature. They are more mealy.

• STUFFED BAKED POTATOES

1. Bake potatoes.
2. Cut a slice from one side. Scoop out the inside and mash thoroughly.
3. Add salt, pepper, hot milk and butter, beat until fluffy.
4. Pile mixture lightly into shells.
5. Bake in hot oven, 425°, until brown.

• SPECIAL STUFFINGS

For extra flavour, here are some suggestions for stuffed potatoes. Small portions of leftover peas, cooked meat, etc., can be used up in this way. Use method for Stuffed Potatoes and mix in for each potato one of the following:

1. 3 tbsp. grated cheese
2. 1 tbsp. diced onion
3. 1 tbsp. diced green pepper cooked 2 minutes in butter
4. ¼ c. cooked meat, 1 tsp. diced onion
5. 2 tbsp. crisp bacon bits, 1 tsp. chopped chives or parsley
6. ¼ c. salmon, 2 tbsp. cooked peas

• FRANCONIA POTATOES

1. Parboil potatoes, remove jackets.
2. Place in roast pan beside beef or pork roast.
3. Bake in slow oven, 325°, until tender and browned, about 40 minutes.
4. Turn potatoes over in the fat several times during cooking.

FRIED POTATOES

• COTTAGE FRIED POTATOES

1. Slice cooked potatoes thinly.
2. Fry in small amount of fat in frying pan until underside is brown.
3. Cover a few minutes to steam.
4. Turn to brown other side.

• FRIED RAW POTATOES

1. Cut pared potatoes in thin slices.
2. Pan fry in a covered frying pan 10 minutes.
3. When brown, add salt and pepper.
4. Turn slices over and fry uncovered.

Variation: Onion slices may be added.

• HASHED BROWN POTATOES

1. Add 3 cups diced cooked potatoes to 3 tbsp. fat in hot frying pan.
2. Sprinkle with ¼ cup milk, 1 tsp. salt, ¼ tsp. pepper. Press potatoes down in the pan, packing them firmly.
3. Cook slowly without stirring until browned on underside, about 20 minutes.
4. Fold in half like an omelet and serve on hot platter.

• FRENCH FRIED POTATOES

1. Cut pared potatoes into strips lengthwise, or thin slices.
2. Soak 45 minutes in very cold water. Drain and dry thoroughly.
3. Fry in hot deep fat until brown, 3 to 5 minutes.
4. Drain on absorbent paper, sprinkle with salt.

NOTE: To test correct temperature of fat:

(a) When an inch square of bread browns in 60 seconds, the fat is at correct temperature for frying raw potatoes.

(b) If a thermometer is used, fry at 370°.

• OVEN POTATO CHIPS

1. Cut pared potatoes into strips lengthwise.
2. Soak 45 minutes in very cold water. Drain and dry thoroughly.
3. Place in a greased shallow pan to make a thin layer and brush with melted fat. Turn chips and brush all sides with fat.
4. Bake in very hot oven, 450°, 30 minutes. Turn several times during cooking.
5. Drain on absorbent paper, sprinkle with salt.

• POTATO CROQUETTES

2 c. mashed or diced potatoes
2 tbsp. butter
1 egg yolk
1 tbsp. diced onion
½ tsp. salt
⅛ tsp. pepper
¼ tsp. celery salt

1. Mix ingredients and beat.
2. Shape into cones or cylinders, dip in bread crumbs, then in egg and in crumbs again.
3. Fry in hot deep fat until brown. Drain on absorbent paper.
   Serves 4-6.

NOTE: To test temperature of fat:

(a) When an inch square of bread browns in 40 seconds, the fat is at correct temperature.

(b) If a thermometer is used, fry at 380°.

• POTATO PANCAKES

2 c. grated raw potatoes
¼ c. milk
1 egg, beaten
2 tbsp. flour
1 tsp. salt
f.g. pepper
1 tbsp. diced onion (optional)

1. Add potatoes to milk and allow to stand 5 minutes. Drain off milk.
2. Blend egg, flour, and seasonings and add to potatoes.
3. Drop by tablespoons into hot greased frying pan. Brown on both sides.
   Serves 4.

- Serve potato pancakes with pot roast and vegetables.
- Omit onion and serve pancakes with apple sauce or syrup.

POTATO SALAD

POTATO SALADS

POTATO SALAD—COLD

2 c. diced cooked potatoes
1 c. diced celery
¼ c. finely diced onion
¼ c. chopped pickles
½ c. salad dressing
1 tsp. salt
¼ tsp. pepper
⅛ tsp. curry powder
¼ tsp. paprika
¼ c. chopped parsley

1. Toss lightly together.
2. Chill and allow to stand an hour before serving.
3. Taste. Add additional seasoning if desired.
   Serves 4-5.

• POTATO SALAD—HOT

¾ c. diced salt pork or bacon
¼ c. diced onion
4 c. diced cooked potatoes
¼ c. vinegar mixed with ¼ c. water
2 tsp. salt
½ tsp. celery salt
2 sweet pickles, chopped
1 hard-cooked egg, chopped

1. Fry pork until nearly crisp, add onions and cook until onions are lightly browned.
2. Remove pork and onions from fat. Place in top of double boiler.
3. Add potatoes, pickles and egg.
4. Add vinegar.
5. Season.
6. Cook over boiling water. Stir occasionally with fork. Serve hot.
   Serves 6.

• POTATO SALAD—MARINATED

3 c. diced cooked potatoes
1 tbsp. diced onion
½ tsp. salt
f.g. pepper
¼ c. French dressing (see recipe, page 18)
¾ c. mayonnaise
2 hard-cooked eggs, chopped

1. Combine potatoes, onions and seasonings.
2. Add French dressing and mix lightly.
3. Chill for 2 hours.
4. Add mayonnaise and toss lightly. Blend in chopped egg.
5. Serve on crisp lettuce, garnish with tomato wedges.
   Serves 6.

• POTATO ASPIC SALAD

1⅔ tbsp. gelatine
¼ c. cold water
2 c. tomato juice or strained canned tomatoes
1 tbsp. sugar
½ tsp. salt
½ bay leaf
¼ c. mild vinegar
1½ tbsp. lemon juice
recipe of potato salad (page 15)

1. Soak gelatine in cold water.
2. Heat ½ c. tomato juice, sugar, salt and bay leaf for 5 minutes, covered.
3. Add to soaked gelatine, stirring until gelatine dissolves. Strain if necessary.
4. Add remaining tomato juice, vinegar and lemon juice.
5. Pour half gelatine mixture into oiled loaf pan or individual moulds.
6. Chill and when firmly set, add a layer of potato salad.
7. Pour remaining gelatine mixture over potato layer. Chill until firm.

Serves 6.

• POTATO AND MEAT SALAD LOAF

1 tbsp. gelatine
¼ c. cold water
1-12 oz. tin luncheon meat or 1½ c. diced cooked meat
¼ c. diced onion
½ c. mayonnaise
1 tsp. horseradish
1 tsp. prepared mustard
recipe of potato salad (page 15)

1. Soak gelatine in cold water 5 minutes, add to mayonnaise and blend.
2. Combine all ingredients for meat salad.
3. Spread a layer of meat salad 1″ deep in oiled mould.
4. Spread potato salad over meat layer.
5. Chill until firm. Unmould and garnish with devilled eggs, sprigs of parsley.

Serves 6.

POTATO SALAD DRESSINGS

• FRENCH DRESSING

4 tbsp. vinegar
6 tbsp. salad oil
¼ tsp. dry mustard
¼ tsp. salt
f.g. pepper
1 peeled garlic clove

1. Mix all ingredients together.
2. Remove garlic clove after several hours.
3. Store in covered container in cold place. Shake well before using.

• SOUR CREAM DRESSING

1 c. thick sour cream
2 tbsp. vinegar
½ tsp. salt
f.g. paprika
2 tbsp. sugar
½ c. chopped, drained sweet pickles

1. Combine all ingredients.
2. Store in covered bottle in cold place.

• COOKED MAYONNAISE

(1)
1½ tsp. mustard
1 tsp. salt
2 tbsp. corn syrup or sugar
1 egg
½ c. oil
½ c. vinegar

(2)
¼ c. flour
¼ c. cold water
¾ c. hot water

1. Measure (1) into a large bowl. Stir slightly.
2. Make paste of cold water and flour. Add hot water slowly. Cook and stir until clear.
3. Pour (2) over first mixture.
4. Beat with Dover egg-beater until mayonnaise begins to thicken.
5. After chilling, store in covered jar in cold place.

• QUICK POTATO SOUP

3 tbsp. diced onion
1 tbsp. fat
1½ c. diced potatoes
¾ c. boiling water
2 c. milk
¾ tsp. salt
f.g. pepper

1. Brown onion in fat.
2. Cook potatoes in water until tender.
3. Add milk, onion, salt and pepper. Heat until almost boiling.
   Serves 4-5.

• CREAM OF POTATO SOUP

2 c. scalded milk
1 onion, sliced
4 tbsp. fat
2 c. diced potatoes
½ c. diced carrots
½ c. diced celery
2 c. boiling water
1 tbsp. flour
1 tsp. salt

1. Brown onion in 2 tbsp. fat.
2. Add potatoes, carrots, celery, boiling water. Cover.
3. Boil until vegetables are tender.
4. Cream flour, salt and remaining 2 tbsp. fat together. Add to milk in double boiler. Cook and stir until smooth.
5. Combine sauce with vegetable mixture.
   Serves 6.

• POTATO-SALMON CHOWDER

4 c. scalded milk
3 tbsp. fat
1 c. diced onion
1 c. diced potatoes
2 c. cooked peas
1 c. boiling water
⅓ tsp. paprika
2 tsp. salt
1 lb. red salmon, skinned and flaked

1. Cook onion in fat.
2. Add potatoes, boiling water and seasonings. Cover.
3. Cook until vegetables are tender.
4. Add scalded milk, peas and fish. Heat until almost boiling.
   Serves 6.

• SCALLOPED POTATOES I

Set oven—350°.

1. Wash, pare potatoes and cut in thin slices.
2. Place a layer of potatoes in greased baking dish. Sprinkle with salt, pepper and flour. Dot with butter.
3. Repeat this until dish is ¾ full.
4. Add milk until it shows through top layer of potatoes.
5. Bake in moderate oven, 350°, until potatoes are soft, about 1 hour.

• SCALLOPED POTATOES SUPREME

Follow recipe for Scalloped Potatoes I. Omit milk, cover with 1-10 oz. tin condensed cream of chicken soup, condensed celery soup or mushroom soup.

• SCALLOPED POTATOES WITH PORK CHOPS

Follow recipe for Scalloped Potatoes I. Place pork chops on top of casserole. Turn chops half way through baking time.

• SCALLOPED POTATOES WITH BACON

Follow recipe for Scalloped Potatoes I. Omit butter, place strips of bacon between layers of potatoes.

• SCALLOPED POTATOES II

1 c. scalded milk
2 tbsp. flour
2 tbsp. butter
½ tsp. salt
f.g. pepper
2 c. cooked diced potatoes
1 tbsp. finely diced onion
½ c. buttered crumbs

1. Cream flour, butter and seasonings together. Add to milk in double boiler. Cook and stir until smooth.
2. Add potatoes and onion.
3. Turn into greased casserole. Cover with buttered crumbs.
4. Brown in hot oven, 425°.
   Serves 5-6.

• POTATO AND ONION SCALLOP

3 c. scalded milk
4 tbsp. flour
4 tbsp. butter
½ tsp. salt
f.g. pepper
¾ c. grated cheese
3 medium potatoes, cooked and diced
6 medium onions, cooked and cut in quarters
½ c. buttered crumbs

1. Cream flour, fat and seasonings together in a bowl. Add to milk in double boiler. Cook and stir until smooth. Blend in cheese until melted.
2. Put layers of cubed potatoes and quartered onions in greased casserole. Pour cheese sauce over them.
3. Sprinkle with buttered crumbs.
4. Bake in hot oven, 400°, 20 minutes.
   Serves 6.

POTATO HAM SCALLOP

POTATO SUPPER DISHES

POTATO-HAM SCALLOP

6 medium potatoes
2 c. diced cooked ham
½ c. diced onion
1 tbsp. butter
milk
flour

1. Wash and pare potatoes and cut in thin slices.
2. Place a layer of potatoes in greased casserole, then layer of ham and onion. Sprinkle with flour.
3. Repeat this until dish is full.
4. Season with pepper, dot with butter.
5. Pour in milk until it shows through top layer of potatoes.
6. Bake in moderate oven, 350°, until potatoes are tender, about 1 hour.

   Serves 6.

POTATO SAUSAGE BAKE

POTATO SAUSAGE BAKE

1 lb. link sausages
¼ c. water
4 medium potatoes
1 tsp. salt
f.g. pepper
flour
milk

1. Place sausages in frying pan. Add water and cover. Cook for seven minutes. Drain.
2. Place a layer of sliced potatoes in greased casserole. Sprinkle with salt, pepper and flour.
3. Repeat this until dish is ¾ full.
4. Add milk until it shows through top layer of potatoes.
5. Arrange sausages on top and bake in moderate oven, 350°, until potatoes are soft, about 1 hour.
   Turn sausages once half way through baking time.
   Serves 4-5.

POTATO CRUST PIE

• BEEF STEW

2 onions, sliced
½ green pepper, diced (optional)
3 tbsp. fat
2 lb. stewing meat (cut in 1″ cubes)
3 c. hot water (or 1 c. hot water and 2 c. tomato juice)
1½ c. quartered carrots
1 c. peas
6 stalks celery, cut in 1″ lengths (optional)
2 tsp. salt
f.g. pepper
1 tsp. Worcestershire Sauce

1. Brown onions and green pepper in hot fat.
2. Roll cubed meat in seasoned flour and brown.
3. Cover with hot water and simmer until meat is tender, 1½ to 2 hours. Or, cook in pressure cooker 10 minutes.
4. Add raw vegetables and cook until tender. If pressure cooker is used, cook 5 minutes. Add peas.
5. If desired, thicken gravy with 2 tbsp. flour mixed with ¼ c. cold water.

TO MAKE PIE:

1. Fill a baking dish two-thirds full with hot stew.
2. Cover the stew with seasoned, mashed potatoes.
3. Bake in hot oven, 400°, about 25 minutes or until crust is lightly browned.

Serves 8.

• POTATO-BEEF PATTIES

1 lb. ground beef
1 c. grated raw potato (2-3 small potatoes)
2 tbsp. grated onion
1½ tsp. salt
¼ tsp. pepper

1. Combine all ingredients and mix well.
2. Shape into patties.
3. Place on broiler rack in preheated broiler so tops of patties are about 3″ from heat.
4. Broil on one side until nicely browned, turn and broil on other side. Allow about 10 minutes for each side.
5. Patties may be baked in oven preheated to 350°. Serves 4-5.

• PUFFY POTATO OMELET

1 c. mashed potatoes
3 eggs, separated
1 tbsp. finely diced onion
½ tsp. chopped parsley
3 tbsp. milk
1 tsp. salt
⅛ tsp. pepper

1. Add beaten egg yolks to mashed potatoes.
2. Add onion, parsley, milk and seasonings.
3. Beat egg whites until stiff, fold into potato mixture.
4. Pour into greased frying pan and bake in slow oven, 325°, until brown, about 15 minutes.
5. Turn and fold on hot platter. Serve at once. Serves 4.

• POTATO DUMPLINGS

1 c. flour
4 tsp. baking powder
1 tsp. salt
2 tsp. fat
⅔ c. mashed potatoes
about ½ c. milk

1. Sift dry ingredients into mixing bowl.
2. Cut in fat. Add mashed potatoes.
3. Pour milk into centre of flour mixture. Stir until mixture leaves sides of bowl.
4. Roll out to ½″ thickness. Cut dough with biscuit cutter.
5. Place dumplings on top of simmering stew, cover and cook 12 minutes. Serve at once.

POTATO CHIPS

Crisp, golden brown potato chips are always popular. At meal time or for entertaining, the crunchiness and flavour of chips makes good eating. Potato chips go into lunch boxes, into picnic baskets and are always a good answer for "what-to-serve" at refreshment time.

Potato chips add interest to your recipes and menus:

- Serve potato chips with tomato juice or other appetizer. Chips are a crisp accompaniment to bowls of steaming soup. Serve chips with salads, too.
- Use potato chips whole or crushed as topping for casserole dishes. Try chips as a topping for baked or broiled fish.

Potato chips play an important role at refreshment time. Crunchy chips make a hit served in one of these ways:

- Serve potato chips with tangy apple cider, with fruit punch. Serve chips with hot cocoa, milk shakes or egg nogs.
- Serve a cheese tray with wedges of cheese, crackers and potato chips. Or, make a bowl of Cheese Dip (see recipe) for dunking potato chips.

6 eggs, hard-cooked
3 c. coarsely crushed potato chips
2 c. scalded milk
4 tbsp. flour
4 tbsp. butter
1 tsp. salt
⅛ tsp. pepper
½ c. grated cheese

1. Cut eggs in halves lengthwise. Arrange on layer of potato chips in casserole. Cover with chips.
2. Cream flour, butter and seasonings together. Add to milk in double boiler. Cook and stir until smooth.
3. Add cheese to sauce and blend. Pour over eggs. Top with whole potato chips.
4. Bake in moderate oven, 350°, 20 minutes.
Serves 6.

• CHEESE DIP

2-4 oz. pkg. cream cheese
1 tbsp. cream
1 tbsp. mayonnaise
1 tsp. vinegar
2 tbsp. chili sauce
¼ tsp. Worcestershire sauce
⅛ tsp. salt
1 tbsp. diced onion

1. Combine ingredients and blend into a smooth sauce.
2. Serve with potato chips.

• POTATO CHIP-TUNA CASSEROLE

3 c. coarsely crushed potato chips
1-7 oz. tin tuna, flaked
1-10 oz. tin cream of mushroom soup
¾ c. milk
2 tbsp. finely diced onion
½ tsp. salt
f.g. pepper

1. Arrange half of the potato chips in bottom of casserole.
2. Cover with half of the tuna.
3. Repeat layers.
4. Combine mushroom soup, milk, onion and seasonings. Pour over fish.
5. Garnish with whole potato chips. Bake in moderate oven, 350°, 30 minutes.
Serves 5-6.

POTATO GARNISHES

There is colour magic in a simple garnish. Some of these ideas take only a few seconds between the stove and table, but potatoes will hold the spotlight and give dinner plates colour and appetite appeal.

Cheese—Roll boiled potatoes in melted butter, then in grated cheese. Brown in hot oven, 425°.
Chives—Roll boiled potatoes in melted butter and minced chives.
Mint—Roll boiled potatoes in melted butter and chopped mint leaves.
Parsley—Roll boiled potatoes in melted butter and chopped parsley.
Paprika—Garnish boiled, creamed or baked potatoes with paprika.

POTATO SEASONINGS

For new flavour interest, try a different seasoning the next time you serve potatoes in a casserole, salad or soup. Careful seasoning can make good food taste even better.

Onion
Garlic
Horseradish
Grated orange rind
Thyme
Marjoram
Curry powder
Celery salt

POTATO-VEGETABLE DINNERS

Serve a colourful vegetable plate. Plan the menu using potatoes along with three other vegetables. Consider colour combinations carefully to make the plate attractive. Select vegetables and ways of cooking that will provide variety in flavour and texture as well. For protein in the meal, include milk, eggs or cheese in a sauce or stuffing. Be sure to have all the vegetables ready at the same moment and then serve the vegetable plate piping hot.

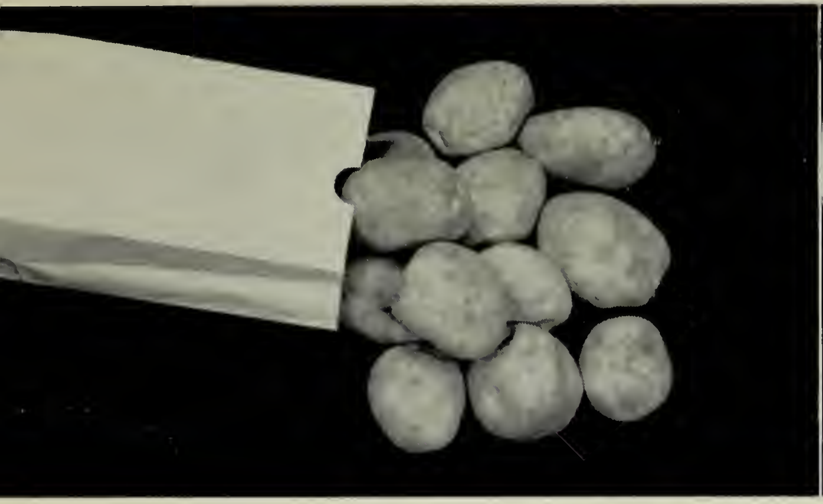
VEGETABLE PLATE SUGGESTIONS

1. Potato Ham Scallop
   Baked Tomato
   Broccoli
   Glazed Carrots

2. Stuffed Baked Potato
   Harvard Beets
   Buttered Spinach
   Baked Squash

3. Baked Potato
   Cauliflower with Cheese Sauce
   Buttered Green Beans
   Kernel Corn

4. Potato and Onion Scallop
   Sliced Tomato
   Diced Celery and Peas
   Asparagus Tips



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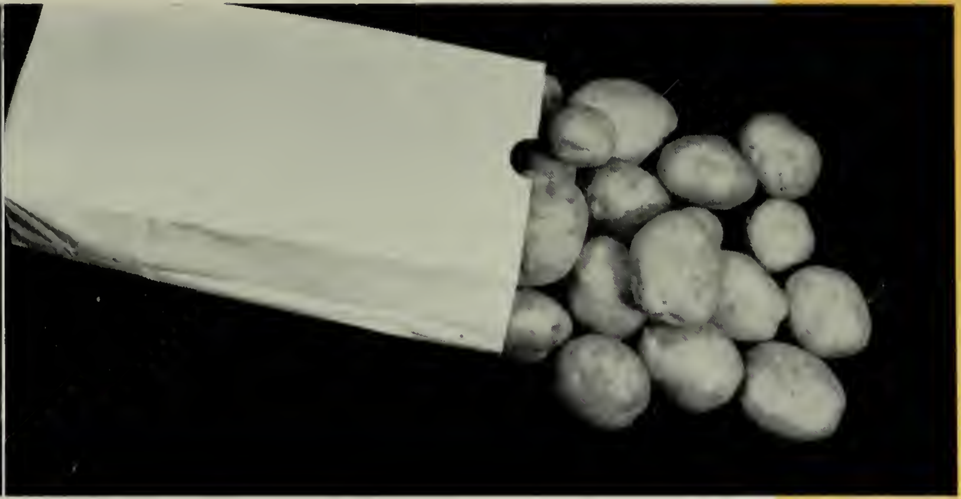

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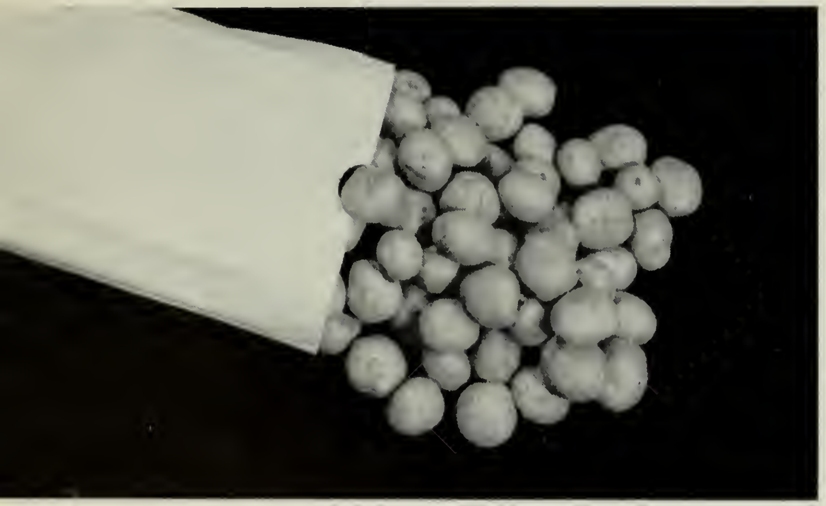
Ask for Ontario Potatoes



Canada No. 1 Small

BUY BY GRADE . . .

This bulletin was prepared by the Nutrition Section of the Women's Institute Branch and Home Economics Service, Ontario Department of Agriculture. All recipes in this bulletin have been tested and approved.

BULLETIN No. 496

NOVEMBER, 1953

INTERNAL PARASITES OF SWINE

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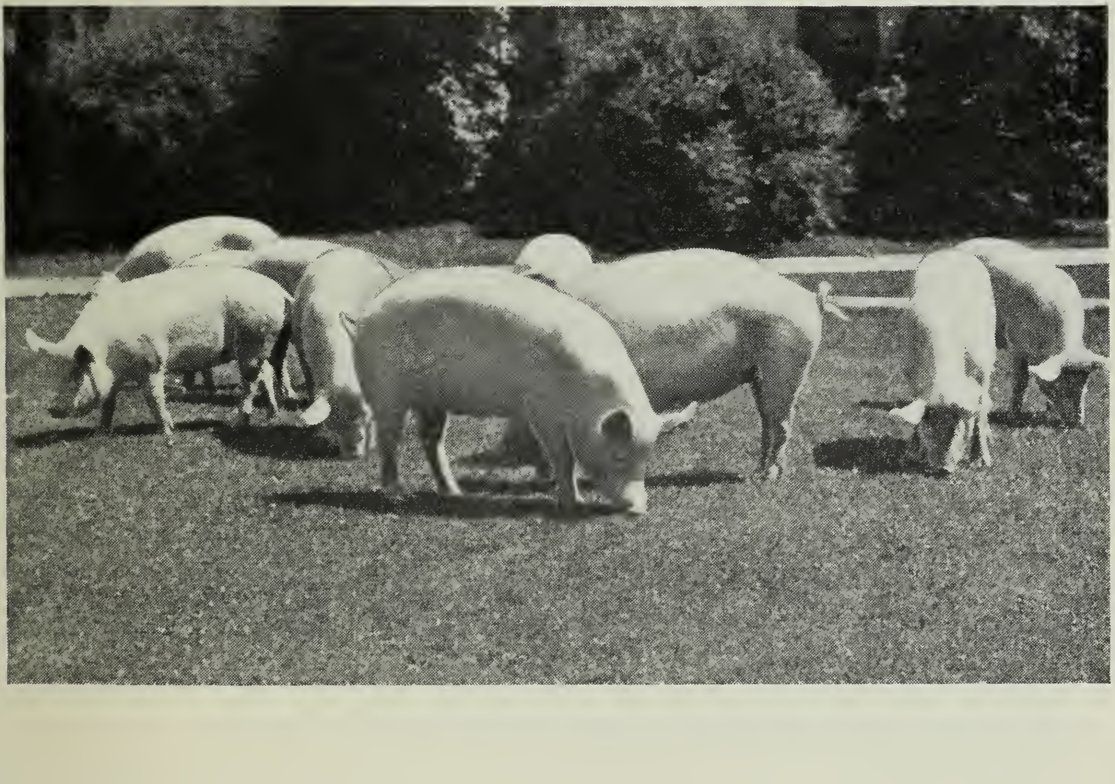
ONTARIO VETERINARY COLLEGE
GUELPH, ONTARIO



ONTARIO DEPARTMENT of AGRICULTURE
PARLIAMENT BUILDINGS, TORONTO, CANADA

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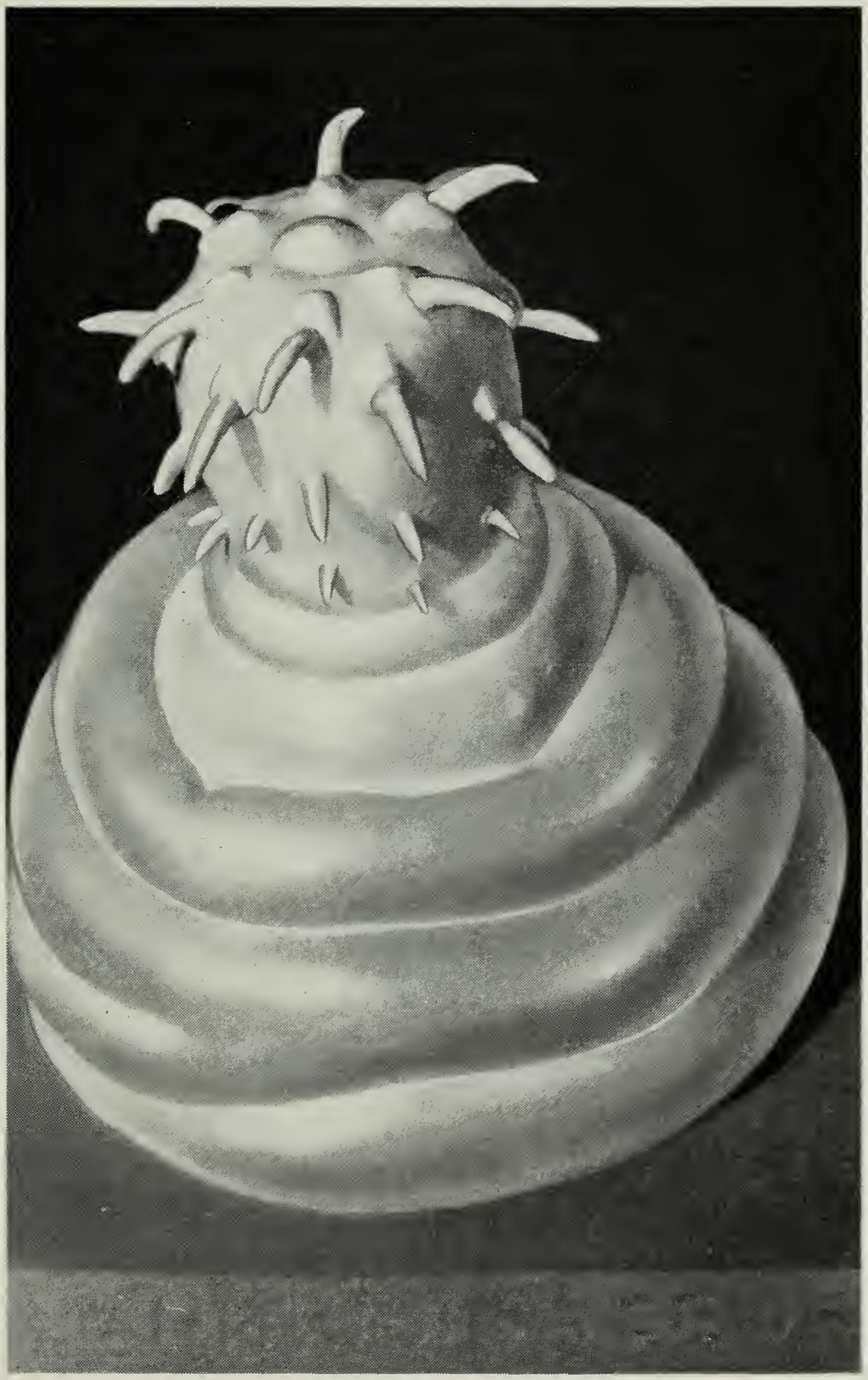

THORNY-HEADED WORM. (Greatly enlarged model of head end showing hooks which become embedded in the wall of the intestine).

FOREWORD

This bulletin has been written to assist hog producers and veterinarians, working co-operatively, to increase profits by reducing losses from parasitism.

The parasites are grouped together under the systems or organs in which they are found. Many of the drawings are silhouettes showing only the natural shape and actual size of the parasites. This grouping and method of illustrating each kind of parasite has been selected to simplify identification. In cases where similar parasites are present in any one organ a miscroscopic examination may be necessary in order to confirm the identification of the species. Illustrations of microscopic parasites are enlarged up to several hundred times their actual size.

Although many of the parasites discussed infest pigs on the North American continent, some worms have been described which so far do not. These have been included so that in the event of their introduction into the New World they may be recognized. A number of other parasites recorded from pigs only on rare occasions have been omitted.

To avoid repetition, methods of control and treatment for the various groups of parasites have been summarized at the end of the bulletin.

The material in the text has been drawn from numerous sources. It is hoped that the form in which the data are presented will prove instructive and practical.

The manuscript has been reviewed by the late Dr. J. L. S. Anderson, Department of Medicine and Surgery and by Professor R. G. Knox, Department of Animal Husbandry.*

The drawings in Plate I are the work of the author. All others have been made by Miss E. P. Rolph, either from actual specimens or as otherwise indicated. The photographic work has been done by Dr. H. J. Neely, Messrs. T. B. Gellatly, R. H. Ellis* and J. J. Hooshley*. Plate VII was finished by Tomlen Photography, Guelph.

*Ontario Agricultural College

INTERNAL PARASITES OF SWINE

CONTENTS

INTRODUCTION Page

Damage Caused by Parasites 1
Origin of Parasites 1
Various Kinds of Internal Parasites 4

PARASITES OF THE ALIMENTARY CANAL

Mouth, Tongue and Gullet

Gullet Worms 4

Stomach

Thick Stomach Worms 5
Red Stomach Worms 5

Intestine

Intestinal Flukes 5
Tapeworms 6
Intestinal Threadworms or Diarrhoea Worms 6
Large Intestinal Roundworms 7
Thorny-headed Worms 10
Hookworms 11
Pimply Gut or Nodular Worms 11
Whipworms 12
Coccidia 15
Balantidia 15
Amoebae 15

PARASITES OF THE LIVER

Liver Flukes 16
Hydatid Worms 16

PARASITES OF THE BODY CAVITIES

Bladder Worms or Water Balls 18

PARASITES OF THE RESPIRATORY SYSTEM

Lung Flukes 19
Lungworms 19

PARASITES OF THE UROGENITAL SYSTEM

Kidney Worms 21

CONTENTS — Cont'd.

PARASITES OF THE MUSCLES

Pork Bladder Worms or Measles 22
Garbage Worms 24
Pork Muscle Fungi 26

CONTROL

Large Intestinal Roundworms 27
Kidney Worms, Stomach Worms, Nodular Worms, Hookworms, and Whipworms 28
Gullet Worms, Thorny-headed Worms and Lungworms 28
Intestinal and Lung Flukes 29
Water Balls, Hydatids and Measles 29
Parasites Transmissible from Pigs to Man; Protozoans, Garbage Worms and Muscle Fungi 29

TREATMENT

Contraindications 30
Hygiene, Feeding and Nursing 30
Preparation 31
Individual Treatments — Methods of Restraint and Administration of Medicines 31
Mass Treatment (See Phenothiazine)

SODIUM FLUORIDE 33

OIL OF CHENOPODIUM or OIL OF AMERICAN WORMSEED 33

SANTONIN 35

PHENOTHIAZINE 35

CARBON TETRACHLORETHYLENE 36

CARBON DISULPHIDE 36

HEXYLRESORCINOL 36

SULPHONAMIDES 36

SKIM MILK 36

MISCELLANEOUS 36

INTERNAL PARASITES OF SWINE

Prepared by
A. A. KINGSCOTE, V.S., D.V.M., D.V.Sc.
Department of Parasitology
Ontario Veterinary College
Guelph, Canada

INTRODUCTION

The hog producer profits in proportion to the number and quality of pigs he is able to market under sound conditions of management. These conditions include carefully planned breeding, feeding, housing and sanitation.

Hogs will thrive under favourable conditions. They are exposed, occasionally, to acute outbreaks of disease caused by bacteria or viruses. In contrast to diseases of this type, there are the less spectacular diseases caused by parasites. Certain of these parasites are present in most herds. Under conditions of good swine husbandry they may cause no serious concern. Once, however, their numbers increase to a certain level, usually owing to diet deficiencies or faulty sanitation, the presence of parasites will cause small litters, stunted growth, deaths and reduced profits.

The purpose of this bulletin is to familiarize the reader with the internal parasites of pigs, to indicate how pigs become infested, and to describe proven methods of prevention and control.

Damage Caused by Parasites

Losses caused by parasites will vary with the numbers present, the kinds infesting particular herds, and the standards of sanitation on different farms. Deaths and failure to make profitable gains in weight are the usual causes of loss. In addition, at slaughter, entire carcasses or parts of carcasses may have to be condemned as a result of parasitism. These losses may be caused by large worms blocking the passage of food in the pig's intestines, or by worms wandering, sometimes in great numbers, through the muscles, liver and lungs, destroying tissues as they go. Certain worms suck blood or devour tissues for their food; others give off poisonous substances, while some cause abscesses and nodules, bronchitis, pneumonia or diarrhoea. Coccidia and other protozoans (very small parasites only visible under the microscope) at times damage the bowels.

The Origin of Parasites

In order to prevent pigs becoming infested with parasites, it is a help to know some of the facts about the parasites themselves. In the first place there are many kinds of worms and protozoans which live in damp soil, but because of their small size many are seldom seen. Evidence points to these harmless soil

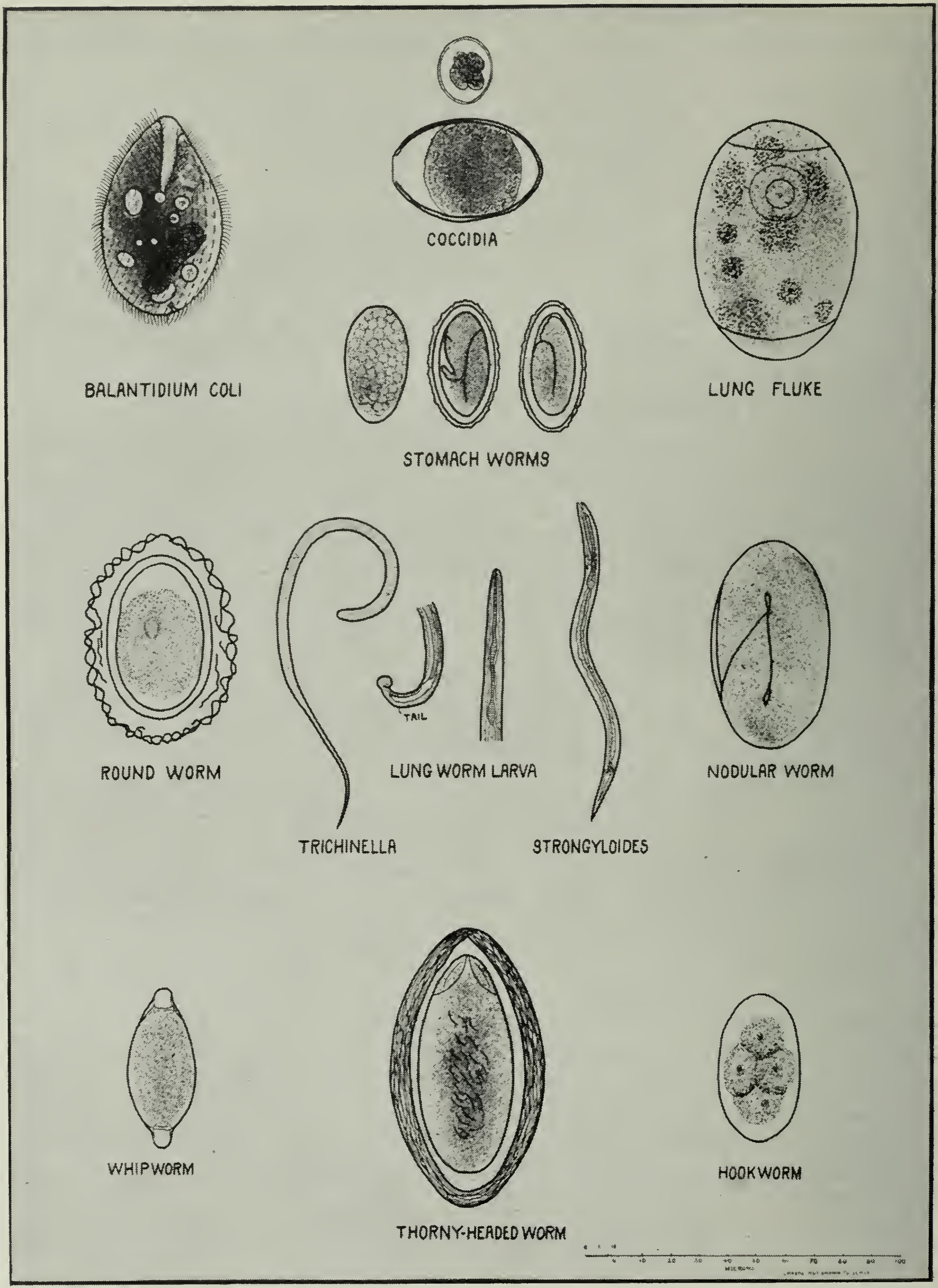

Plate I. Illustrations of the eggs, larvae and protozoan parasites of swine. Dirty pens and pastures may contain vast numbers of these microscopic forms. *(Redrawn after various authors).*

forms being the remote ancestors of the harmful ones in our animals. After being swallowed by foraging swine, some of these creatures have adapted themselves to life in the intestines, others to existence in the lungs and so on — until now, through force of habit, they are unable to live elsewhere, at least during a part of their lives.

Worms multiply by laying great numbers of microscopic eggs. Single worms have been found to produce over 1000 eggs daily and in the neighborhood of 3,000,000 in their life time. It has been estimated that if roundworm eggs were as large as grains of corn, infested hog lots would be covered with layers of eggs over a foot deep.

Eggs of worms which live in the digestive tract or lungs pass out of pigs' bodies in the manure, those from the lungs being first coughed up and swallowed.

It is in pens and pastures that most worm eggs undergo periods of incubation (similar to birds' eggs.) When the young worms are fully formed they are ready to infest pigs which swallow them while feeding or drinking.

Filth by itself never creates parasites but it is usually a dangerous source of infestation because of the large numbers of eggs or young worms it may contain.

Certain worms must spend part of their early life in earth worms, beetles, or snails, which first feed upon the worm eggs in manure and later are themselves devoured by pigs foraging for food.

The eggs and young of many worms have thick or tough shells which protect them from unfavourable weather conditions so that they may survive for months or even years. Usually moist soil, shade and filth favour the development of parasites while dry soil, sunshine, cultivation and cleanliness destroy many.

"Water balls" and hydatids (young tapeworms) get into pigs which have swallowed the eggs of mature tapeworms passed by people or members of the dog tribe. The dung of either on pastures is the source of infection for pigs.

Garbage worms (trichinae) are contracted by pigs eating infested uncooked pork scraps and occasionally dead rats.

Coccidia and similar invisible parasites pass from pig to pig as cysts which are comparable to worm eggs and may be abundant in the manure of diseased pigs.

Most parasites are introduced into piggeries by infested pigs. There is always danger of introducing new parasites with fresh stock. At other times, the eggs or cysts may be brought onto farms on the boots of visitors, by wild birds or rats.

Even though they most likely have some parasites, pigs with ample pastures and clean pens will not become infested as rapidly as those animals which are kept in crowded, unsatisfactory quarters over a prolonged time. The control of parasites is thus very like the control of weeds, but both will increase rapidly in numbers if they are permitted to multiply unchecked.

In the course of their lives, pigs become resistant to heavy invasions of some of the more common parasites. For this reason very young and growing animals are the most likely to suffer. Older stock, although infested, may not suffer, but will contaminate the ground and so infest their less resistant offspring.

Various Kinds of Internal Parasites

The following short descriptions will give the hog producer an idea of the different internal parasites which may infest pigs and cause disease under adverse conditions. A knowledge of the parasites is the best safeguard for the timely prevention of loss which they are capable of causing.

PARASITES OF THE ALIMENTARY CANAL

Mouth, Tongue and Gullet

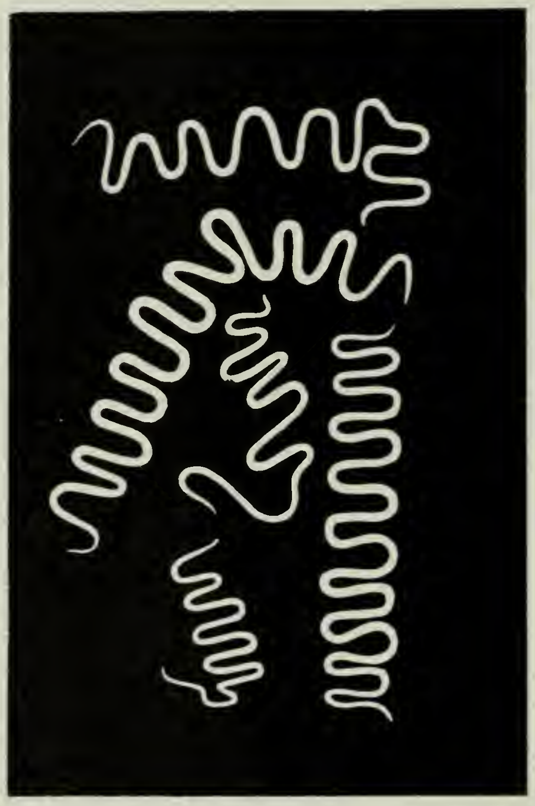

Fig. 1. Gullet Worms, *Gongylonema pulchrum* Molin, 1857.
Natural size.

Swine Gullet Worms, *(Gongylonema pulchrum)* live in burrows which they make in the lining of the mouth, tongue and gullet. The burrows are zig-zag in pattern and the thread-like worms grow up to five inches in length. Besides pigs the worms may infest other farm animals and occasionally people. The worms require dung beetles or cockroaches in which to spend the first stages of their existence. Pigs get gullet worms by eating the insects which have been feeding on manure.

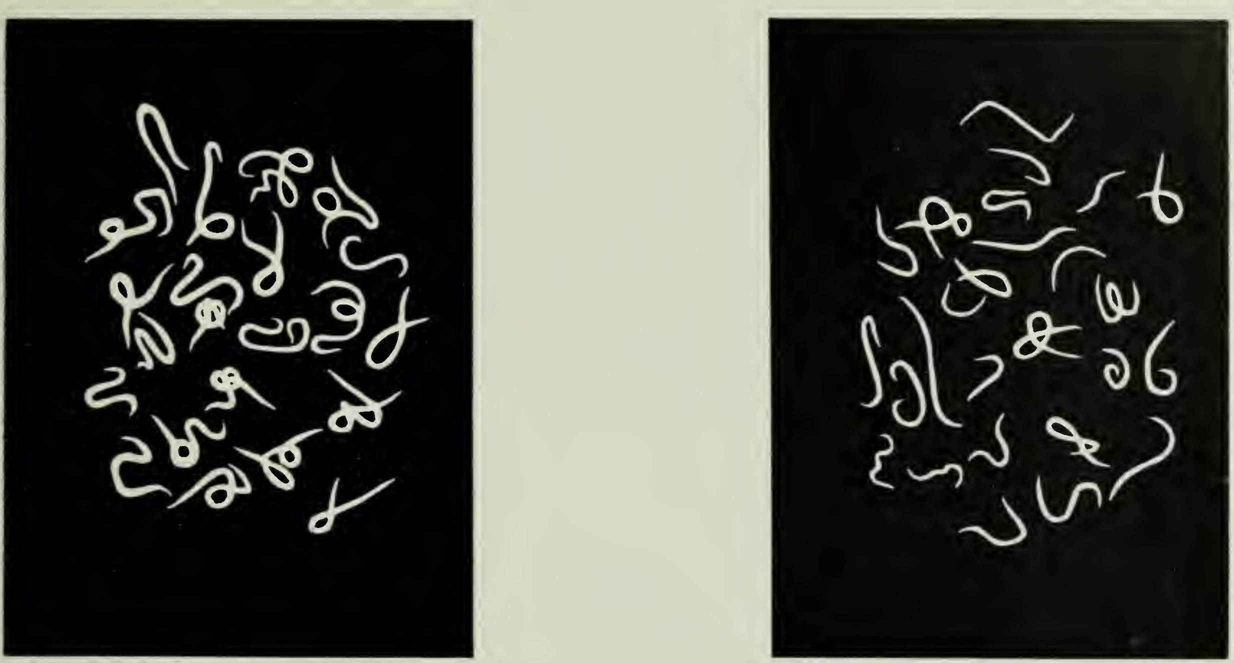

Fig. 2. Stomach Worms. Left, thick stomach worms, *Ascarops strongylina* (Rudolphi, 1873); right, red stomach worms, *Hyostrongylus rubidus* (Hassall and Stiles, 1892). Natural size.

Stomach

Stomach Worms. Besides the common large round worms which are seen frequently in the stomachs of the pigs, there are at least three other kinds of worms which live in the stomach. They range variously in length from one-quarter to three-quarters of an inch. Two are named the Thick Stomach Worms *(Ascarops strongylina* and *Physocephalus sexulatus)* and others because of their colour, the Red Stomach Worms *(Hystrongylus rubidus).* All three kinds suck blood. They either lie close to the wall of the stomach or burrow into it, making wounds from which only the tails of the parasites protrude, and into which dangerous bacteria *(Bacillus necrophorus)* enter and cause inflammation and ulcers. When these worms are very numerous pigs lose their appetites, become thirsty, fail to thrive and may die. The thick stomach worms require dung beetles, like the gullet worms, in which to start their lives. The red stomach worms get into pigs when swallowed as young worms in filth contaminated food or drinking water.

Intestine

The small intestine, extending from the stomach to the large intestine, reaches a length of 65 feet in adult pigs. The lining of the intestine, the blood in its walls and the partially digested contents in its interior supply ample food for a variety of worms and minute parasites which make the gut their home. The small intestine is followed by the blind gut, colon and rectum, comprising the large intestine.

Intestinal Flukes or Flatworms *(Fasciolopsis buski, Echinochasmus perfoliatus, Metagonimus yokogawsi* and *Brachylaemus suis)* are chiefly parasites of swine in certain parts of the Old World. These worms may cause digestive disturbances, inflammation of the bowel and pain. Their development is similar to that of the liver flukes (see page 18). The largest of these flukes *(F. buski),* which may be nearly two inches long and half an inch wide, also infests people, who in China and elsewhere, eat the raw roots and nuts of water chestnuts and similar plants fertilized with human or pig manure which contains the eggs of the flatworms.

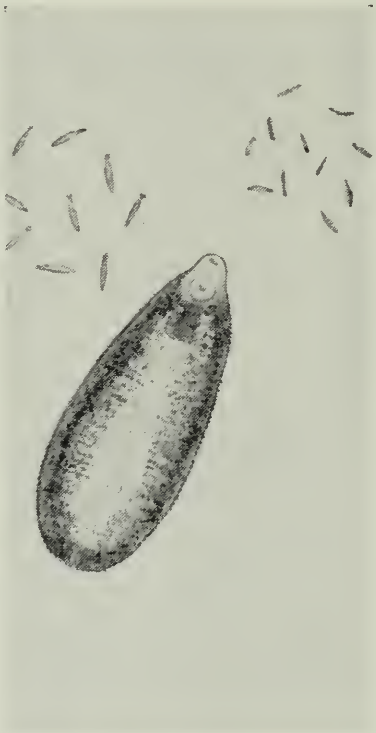

Fig. 3. Intestinal Flukes. Top left, *Echidnochasmus perfoliatus* (v. Ratz, 1908); top right, *Metagonimus yokogawai* (Katsurada, 1912); bottom centre, *Fasciolopsis buski* (Lankester, 1857). Natural size.

TAPEWORMS *(Cestoda)* as full grown worms, do not occur normally in the intestines of pigs. Occasionally swine which have had access to the intestines of slaughtered animals may be found to contain portions of the common tapeworms of sheep and other animals which they have swallowed but have not had time to digest.

Young developing tapeworms, on the other hand, are important parasites of swine, but they are found in other parts of the body, not in the intestine, and will be described later under the headings of "water balls" and hydatid worms.

INTESTINAL THREADWORMS OR DIARRHOEA WORMS *(Strongyloides ransomi)* are less than one-eighth of an inch in length. Numbers of these worms cause inflammation of the intestines together with diarrhoea, anaemia and thinness in young pigs. Besides entering the body through the mouth, the threadworms also burrow through the skin in which they cause small haemorrhages. Once through the skin the worms enter the blood-stream and eventually find their way to the intestines. Sometimes considerable numbers of the worms are found

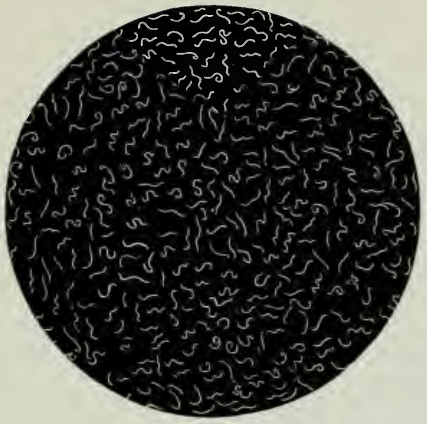

Fig. 4. Intestinal Thread Worms or Diarrhoea Worms, *Strongyloides ransomi* Schwartz and Alicata, 1930. Natural size.

in the heart which is damaged by their presence. Diarrhoea worms, unlike many others, multiply in filth outside the pig's body and in dirty pens there may be a great many of the parasites which are invisible to the naked eye.

Large Intestinal Roundworms *(Ascaris lumbricoides)* when fully developed range from several inches to over one foot in length and nearly a quarter of an inch in thickness. They are yellowish in colour; the males are smaller than the females and have curved tails.

The roundworms are widely distributed. Pigs raised on contaminated ground have been known to harbour from 2000 to over 9000 worms per animal. Female worms lay up to 3,000,000 eggs during their life-time; therefore, once these worms are established in pens or pastures it requires constant care to keep their number down.

The worm eggs are passed from the bodies of pigs in manure. Under favourable conditions young worms are developed within the eggs in 14 days. Infective eggs, microscopic in size, are swallowed by the pigs, then hatch in the small intestine. The young worms burrow through the gut wall and go to the liver, heart and lungs then back to the intestine. In two and a half months the worms mature.

Occasionally, while wandering through the bodies of pregnant sows, roundworms find their way into unborn pigs.

Swine roundworms, are not the same as those found in man and other farm animals, although they look very much alike.

Young pigs often become infested with roundworms before they are weaned. Worms not only retard their growth but may permanently injure them or cause death in several ways. Masses of full-grown worms will completely clog the small intestine and bile ducts, causing digestive disturbances and jaundice. Ulcers, too, may form. Dead worms give off harmful substances which are absorbed by the pigs, add to the general ill health, and damage the kidneys.

Young worms wandering through the body damage the liver; when such pigs survive the liver is sometimes left so badly scarred that it is condemned as unfit for human consumption. The common name for such a condition is "parasitic liver".

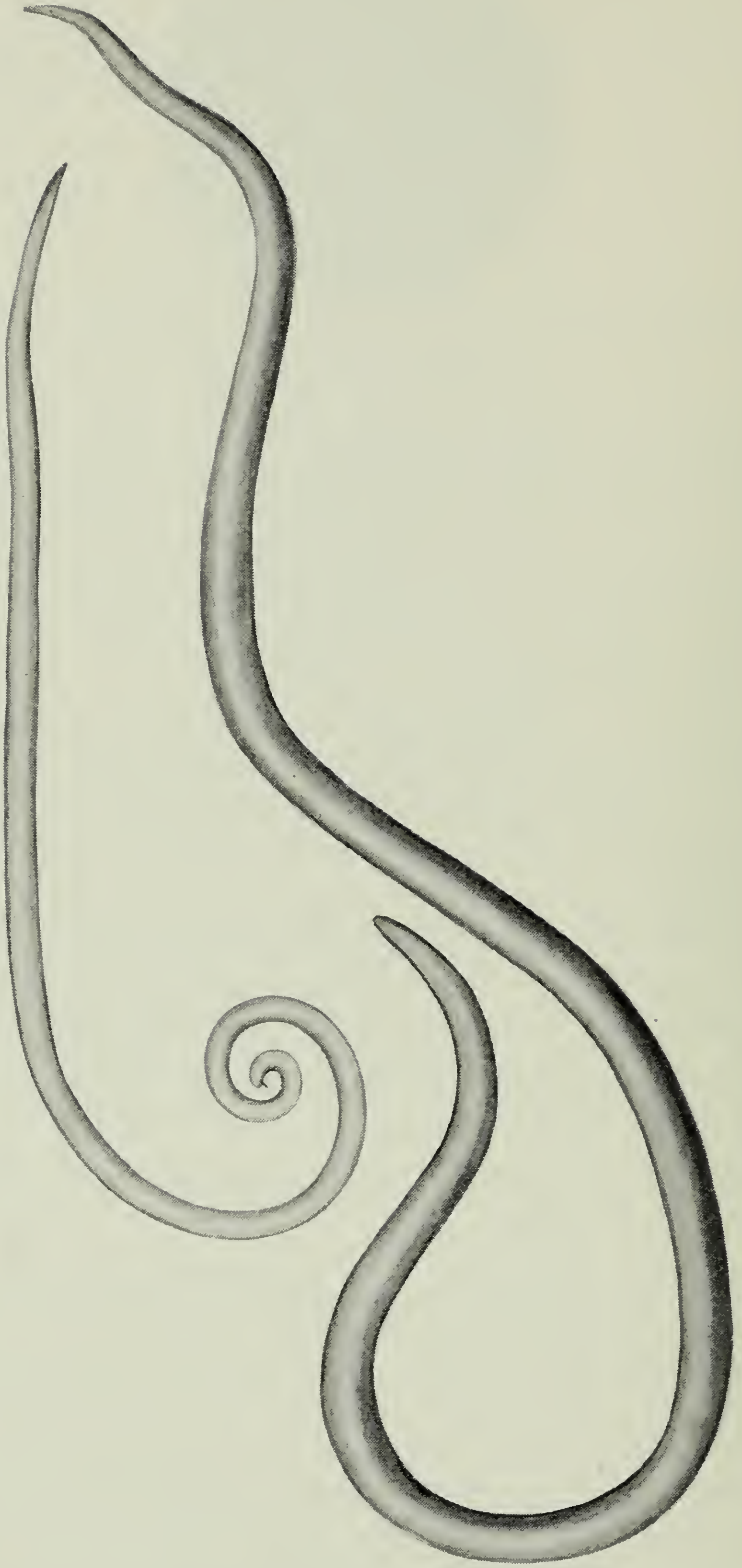

Fig. 5. Large Intestinal Roundworms, *Ascaris lumbricoides* Linnaeus, 1758. Natural size.

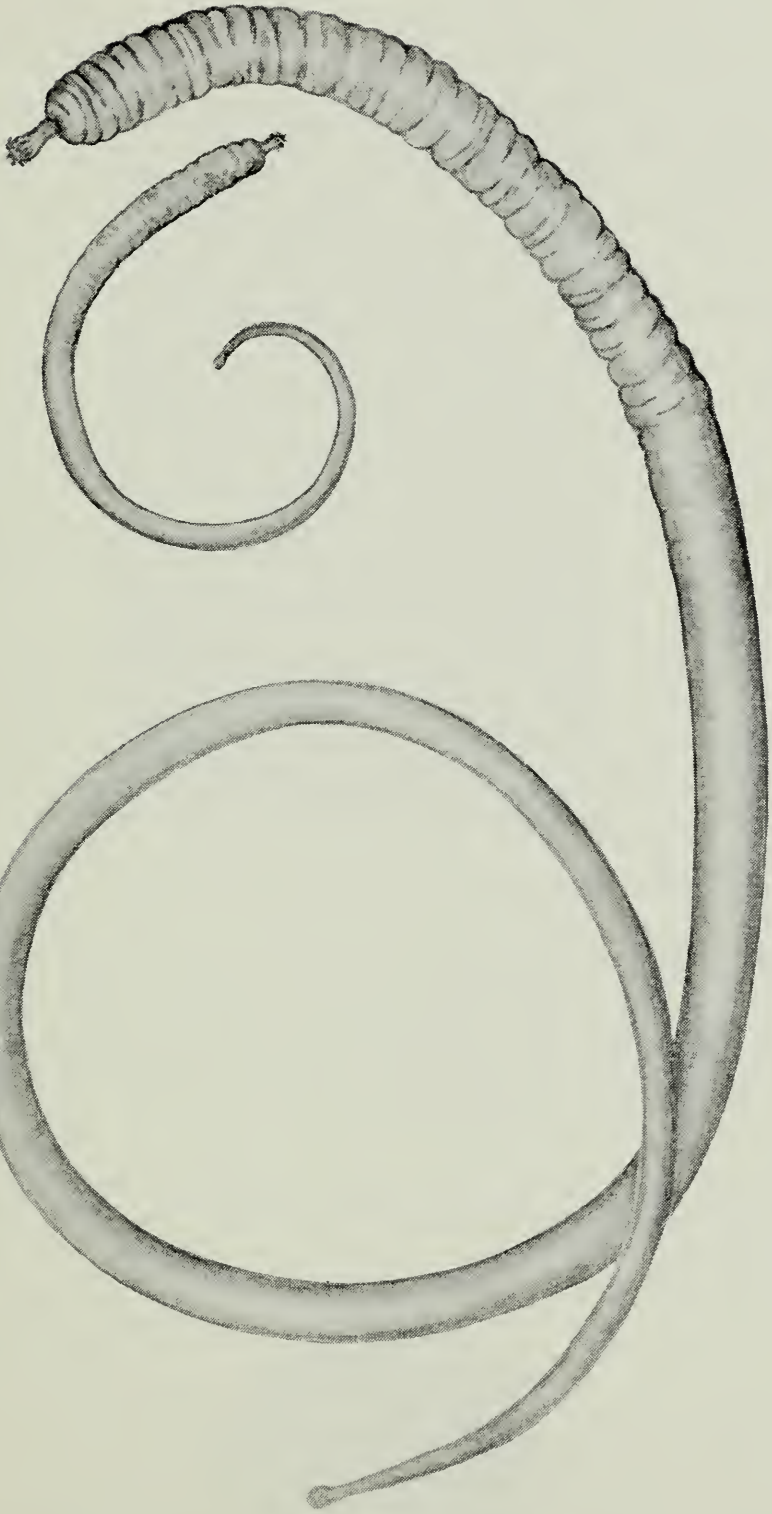

Fig. 6. Thorny-headed Worms, *Macracanthorhynchus hirudinaceus* (Pallas, 1781). Natural size.

Wandering roundworms also do much harm in the lungs. When the parasites reach these organs, very young pigs may crawl into dark corners or under straw. Breathing is difficult, the condition commonly called "thumps" develops, and the pigs may die within a week from "worm pneumonia".

Experiments have shown that pigs raised under sanitary conditions, free from severe roundworm infestations, produce more young and fewer runts per litter and show greater gains in proportion to the amount of food consumed. In a series of tests it has been demonstrated that pigs raised under sanitary conditions produced an average of 11 young per litter, only one per cent runts and weighed 212 lb. in six months, while pigs raised under insanitary conditions, other factors being equal, averaged five young per litter, 18 per cent runts and weighed only 180 lb. in eight months.

Thorny-Headed Worms *(Macracanthorynchus hirudinaceus)* range in length from two inches to over one foot. They are distinguished from roundworms by being attached to the walls of the intestines, usually having curved bodies and in being slightly flattened, wrinkled, and gradually tapered backwards. Their colour varies from milky white to pink. Female worms each lay a quarter of a million eggs daily for a period of ten months, and these eggs will remain dangerous three and a half years in pastures.

Thorny-headed worms are found only in pigs in certain localities where suitable kinds of May-, June-, dung- or water-beetles exist. The grubs of these beetles feed on the worm eggs in pig manure. Pigs become infested while rooting and feeding on the grubs or mature beetles. The worms take from three to four months to become full-grown in pigs.

Thorny-headed worms have spine covered structures at their front ends. (See frontispiece.) The spines attach the worms to the intestines and at the same time cause injuries which develop into reddish and yellowish nodules. Bacteria enter the nodules and ulcers form. As the worms move to new places further damage is caused. Infested pigs grow slowly and are unhealthy. Sometimes thorny-headed worms perforate the bowels with fatal results. Damaged intestines are worthless as sausage casings.

Besides pigs, squirrels have been known to harbour the same thorny-headed worms. The worms have been reported in people in certain Old World countries where beetles are used as food.

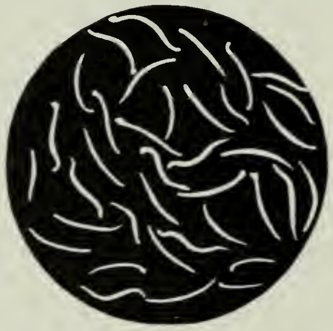

Fig. 7. Hookworms, Globocephalus sp. Natural size. These worms are found chiefly in pigs raised in warm climates.

Swine Hookworms *(Globocephalus urosubulatus)* are a quarter of an inch in length or less. They are attached usually to the wall of the small intestine in which sufficient numbers cause inflammation and haemorrhages followed by anaemia and unthriftiness. Hookworms are most prevalent in places with warm climates.

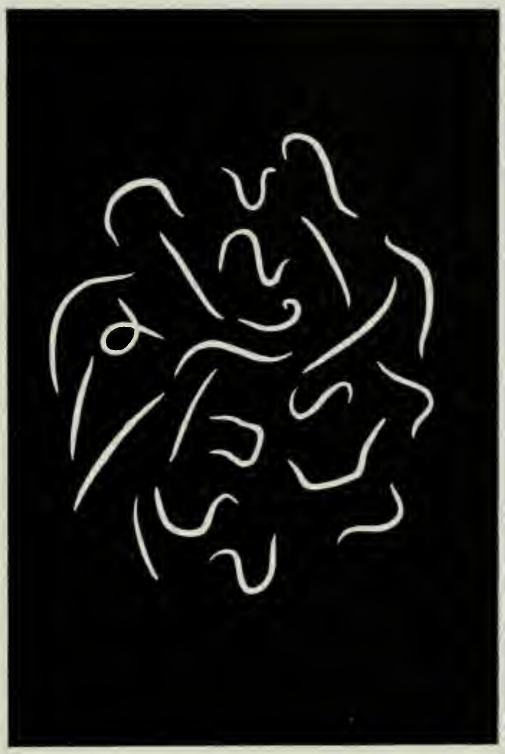

Fig. 8. Pimply Gut Worms, *Oesophagostomum dentatum* (Rudolphi, 1803). Natural size.

Pimply Gut or Nodular Worms *(Oesophagostomum dentatum)* of swine grow to slightly more than half an inch in length. The young worms, after hatching from the eggs in pig manure, live in the ground. They burrow deep into the soil during dry weather and rise to the surface in wet seasons. They can survive for 4 months in pastures or hog lots.

When swallowed by a pig, the worms enter the wall of the intestine where they produce inflammation and pin-head size nodules. Bacteria get into the injured regions. When the damage is great there is interference with the absorption of food. Pigs suffering from this disease may have diarrhoea and become weak, anaemic and emaciated.

Besides the above common worms there are others chiefly occurring in warm climates. The long-tailed nodular worms *(O. longicaudum)* cause severe inflammation and much larger nodules in the blind gut and large intestine. The short-tailed nodular worms (*O. brevicaudum* and others (*O. georgianum*) also inhabit the blind gut and colon of southern pigs.

Swine nodular worms, although similar in effect, are different from those infesting sheep and other animals.

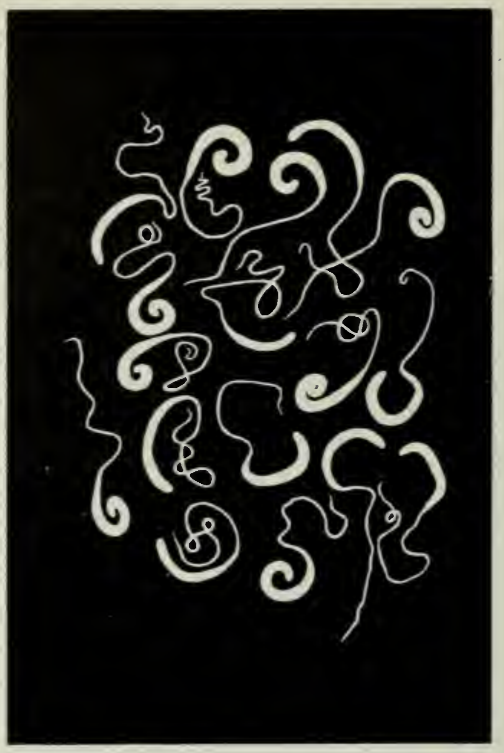

Fig. 9. Whipworms, *Trichuris trichiura* (Linnaeus, 1771). (Syn. *T. suis, T. apri, T. dispar,* etc.). Natural size.

WHIPWORMS *(Trichuris trichiura)* are very common parasites of swine. Their common name has been given them because they resemble a stock whip in form. The mature worms are almost two inches in length. These parasites rest in flat coils against the walls of the blind gut and colon. The thread-like "lash" portions of the worms are embedded in the lining of the bowels.

Female whipworms lay up to 5000 eggs per day. These eggs are not destroyed by cold and will survive in pens and pastures for several years. The eggs are swallowed by pigs and the full-grown worms appear in the bowel three months later.

Usually little harm is caused by whipworms in pigs but sometimes they produce inflammation of the intestines. Harmful bacteria may gain entrance to the gut walls damaged by the whipworms.

Whipworms of swine are similar to those which infest people, in whom they may cause appendicitis, but are different kinds from those found in cattle, sheep, dogs and cats.

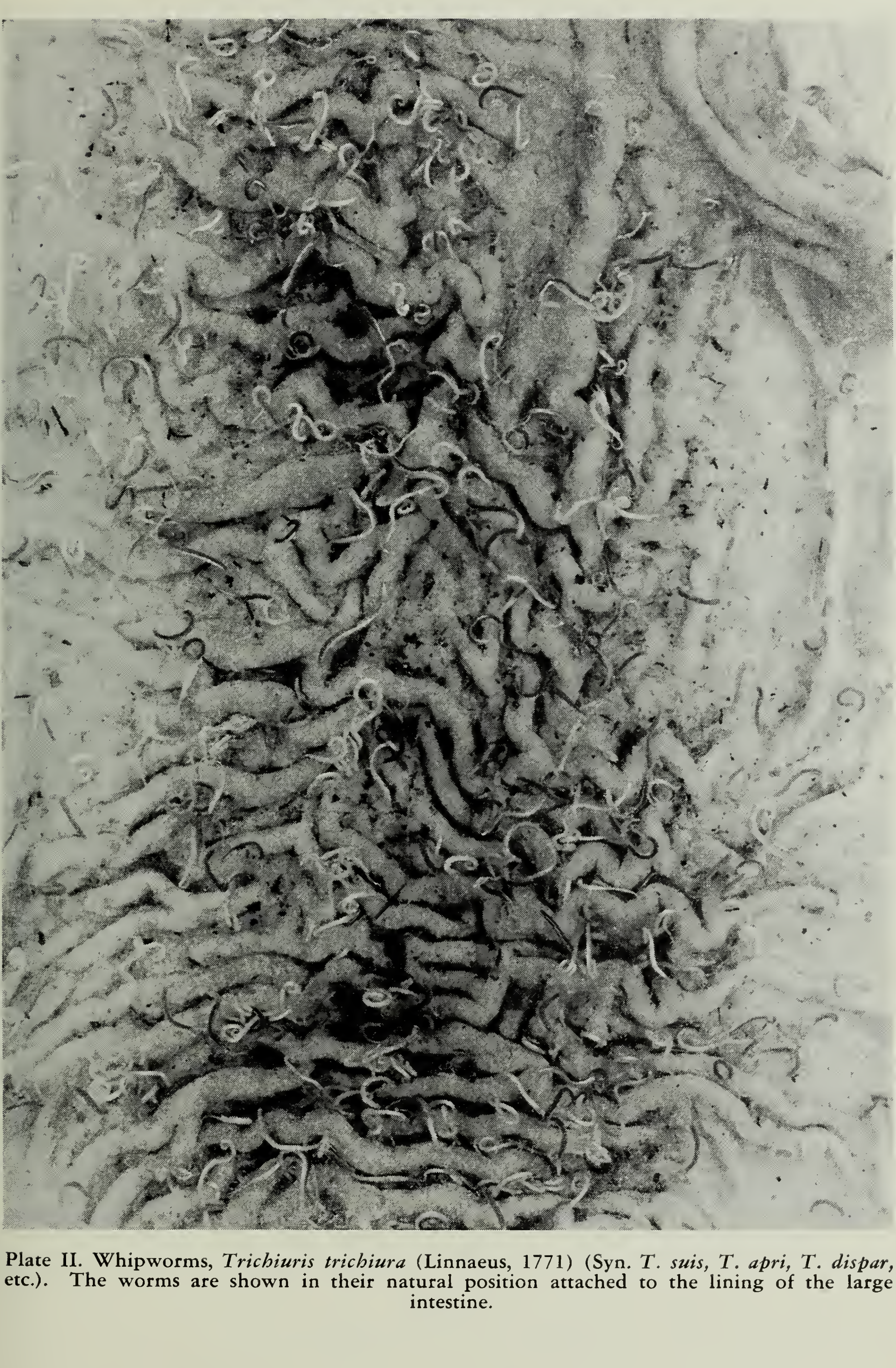

Plate II. Whipworms, *Trichiuris trichiura* (Linnaeus, 1771) (Syn. *T. suis, T. apri, T. dispar,* etc.). The worms are shown in their natural position attached to the lining of the large intestine.

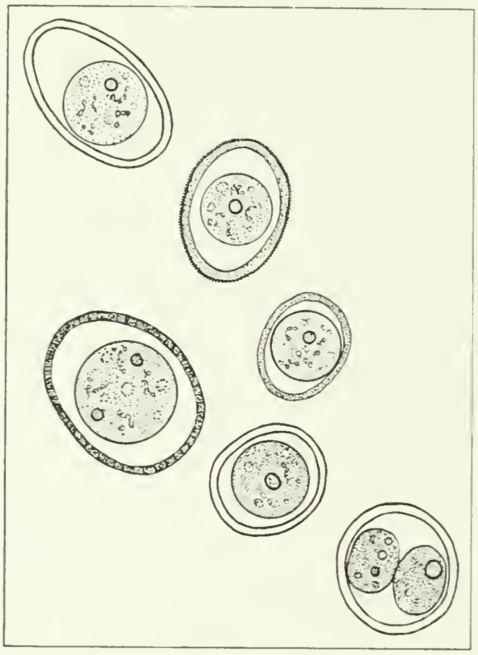

Fig. 10. Coccidia, from top to bottom, *Eimeria debliecki* Douwes, 1921; *E. spinosa* Henry, 1931; *E. perminuta* Henry, 1931; *E. scabra,* Henry 1931 (largest); *Isospora suis* Biester, 1934 (two lowest). (Redrawn after Morgan and Hawkins*).

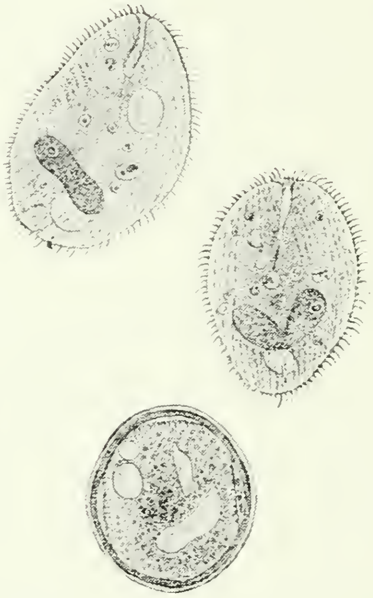

Fig. 11. *Balantidium coli* (Malmsten, 1857). Greatly enlarged. The upper specimens are active forms, the lower one is a cyst or resistant stage. (Adapted from Wenyon).

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* Veterinary Protozoology, 1952. Burgess Publishing Company.

Coccidia *(Eimeria debliecki, E. scabra, E. perminuta, E. spinosa, E. scrofae* and *Isospora suis)* are parasites which can only be seen under a microscope when magnified a hundred or more times. Some of the coccidia, listed here by their scientific names, live in pigs apparently without causing any harm; the first two named above, however, may produce the disease coccidiosis especially in young pigs.

Coccidia are picked up by pigs with food and water contaminated with manure. The parasites, once in either the small or large intestines, multiply rapidly. The harmful sorts cause inflammation and haemorrhages in the bowel wall which may become thickened and unable properly to absorb food and water.

Sick pigs lose their appetites and may have pot-bellies and arched backs. Such animals stop growing and become thin. At first they have diarrhoea, often without blood; in fatal cases constipation precedes death.

In severe cases of coccidiosis, pigs are ill for about three weeks. Often they will recover without any treatment, but may remain unthrifty. Recovered pigs will still continue to pass the coccidia in their manure and it is these animals, known as immune carriers, which keep spreading the disease to new litters of young pigs. The coccidia passed with the manure will remain alive on the ground for some time. The marked unthriftiness of pigs, which is seen on some farms, may be caused by coccidia.

Balantidia *(Balantidium coli)* which means "a little bag in the large intestine" are very common protozoans of swine. They seem to cause no harm in pigs but when transferred from these animals to people damage the human intestine and cause dysentery. The protozoans are passed as cysts in the manure. The cysts may contaminate wells, hands and food, or they may be picked up when cleaning pens, or handling or butchering pigs. The best safeguards against human infections are farm sanitation and personal cleanliness.

Amoebae *(Endamoeba histolytica)* resemble minute masses of jelly under the microscope. Although these parasites do not frequently occur in pigs, they have been considered extremely dangerous ones because they might cause dysentery, abscesses and ulcers in the intestine, liver and other organs of people, who may become infected from swine in the same manner as that described in the above paragraph. (Some investigators, however, doubt that the true *E. histolytica* really occurs in pigs.) In swine there are also several other amoebae, *(E. coli, E. polecki, Endolimax nana* and *Iodamoeba butschlii)* which are apparently harmless, even when present in great numbers.

Miscellaneous Protozoa. Trichomonas, Chilomastix and Giardia are other groups of protozoans found in swine, but they do not appear to cause disease.

PARASITES OF THE LIVER

Liver Flukes *(Fasciola hepatica, Dicrocoelium dentriticum, Opistorchis sinensis* and *O. tenuicollis,* etc.) occur in various parts of the world in the bile ducts or livers of pigs. One of these flukes, *(O. tenuicollis),* has been found in Canadian pigs. Under favourable conditions other flukes could become established.

The liver flukes are flat, often reddish in colour and vary from a fraction of an inch to over one inch in length. They feed on tissues and blood and may cause serious damage to the livers and general health.

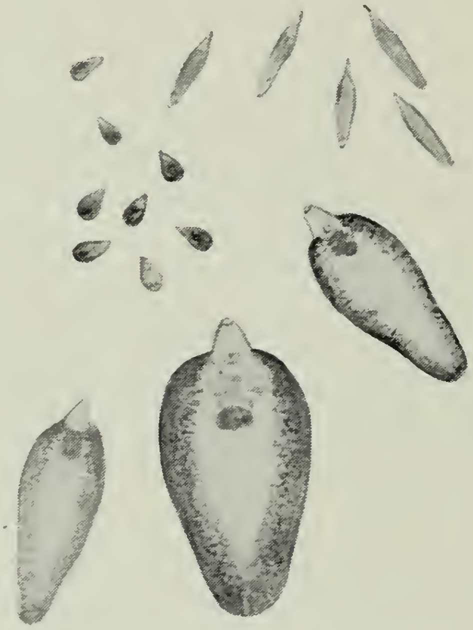

Fig. 12. Liver Flukes. Upper left group, *Opistorchis sinensis* (Cobbold, 1875); upper right group, *Dicrocoelium dentriticum* (Rudolphi, 1819); lower group, *Fasciola hepatica* Linnaeus, 1758. Natural size.

Fluke eggs are passed from the liver, with the gall, into the intestine and thence spread with manure. The eggs of most flukes require wet places in which to develop. After the young flukes hatch, they penetrate certain kinds of snails in which they undergo further development. Later these young flukes leave the snails and attach themselves to plants upon which pigs must forage to become infested.

The lanceolate flukes *(D. dentriticum),* commonly parasites of sheep, but also recorded from pigs, may become established on relatively dry pastures because the early stages of the worms develop in small land snails. These snails drop "slime balls" harbouring many young flukes. Recent research indicates ants may play a role in the spread of these flukes.

Hydatid Worms *(Echinococcus granulosus)* are common in certain countries and are found periodically in pigs in Canada. They are highly dangerous parasites in any community because they may spread from animals to people, causing the serious and sometimes fatal hydatid disease in man.

Hydatid worms commence life in the intestine as microscopic creatures hatching from eggs which have been swallowed. They wander through the body

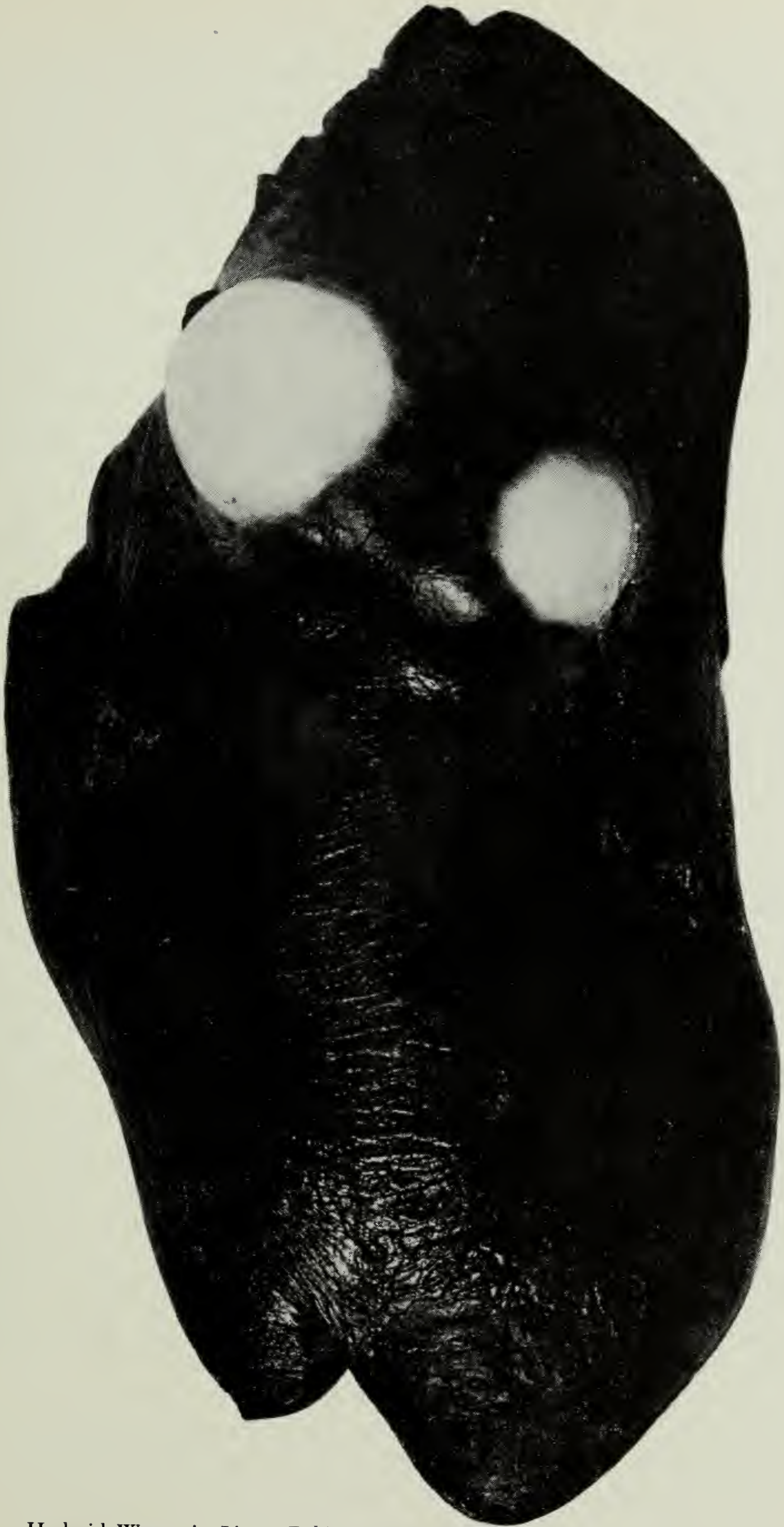

Plate III. Hydatid Worm in Liver, *Echinococcus granulosus* (Batsch, 1786). Reduced from natural size.

of their victim until they reach the liver, lungs or some other organ and there grow into bladder-like forms, some times attaining the size of oranges or grapefruits. Within the fluid-filled bladders (hydatids) each worm develops many small heads resembling grains of sand. Sometimes the heads float in the fluid; occasionally no heads at all form, in which cases the bladders are termed "sterile".

One or several hydatid worms may be found in infested organs which are progressively destroyed as the bladders increase in size. When bladders burst within living animals the results may be fatal.

The next stage in the lives of these parasites is dependent on the bladders being eaten by dogs, wolves, foxes or other flesh-eating animals. Such animals may gain access to the hydatids when feeding on slaughter-house offal or carcasses. Members of the dog tribe, after eating hydatid bladder worms, become infested with many hundreds of tapeworms barely visible to the naked eye, as all the heads in the bladders grow into separate worms.

From flesh-eating animals, the eggs of these worms contaminate pastures where they may infest pigs or other grazing animals which swallow them. Man is most likely to become infested with hydatids by handling dogs which have fed upon slaughter-house offal.

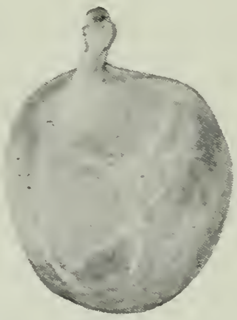

Fig. 13. Bladder Worm or Water Ball, *Cysticercus tenuicollis,* larva of the tapeworm *Taenia hydatigena* Pallas, 1766. Natural size.

PARASITES OF THE BODY CAVITIES

Thin Necked Bladder Worms or Water Balls *(Cysticercus tenuicollis)* are young stages in the lives of tapeworms. They are seen attached by what appears to be a thin neck to the surface of the liver or various parts of the intestines and caul fat. They resemble small bladders filled with fluid and are usually about the size of hazel nuts or walnuts, sometimes larger. Single white spots are often seen within the bladders; these are the heads of the young tapeworms.

Pigs, sheep, cattle and wild ruminants become infested with bladder worms by swallowing the eggs of tapeworms *(Taenia hydatigena)* which are left on the pastures in the manure of infested dogs, wolves, foxes and other flesh-eating animals which carry the fully grown tapeworms in their intestines. The flesh-eating animals just mentioned, while devouring slaughter-house offal or carcasses left exposed on pastures and ranges, swallow the bladder worms which burst and grow to full-sized tapeworms in the intestines.

Bladder worms may harm pigs in their passage through the gut walls on their way to the liver and other sites. Damage caused by numbers of the worms may make livers and caul fat unsuitable for market.

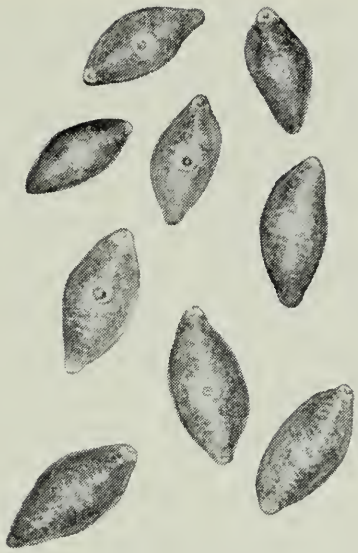

Fig. 14. Lung Flukes. *Paragonimus kellicotti* Ward, 1908. Natural size.

PARASITES OF THE RESPIRATORY SYSTEM

Lung Flukes *(Paragonimus kellicotti)* are approximately the size, shape and colour of coffee beans. They usually are found in pairs in abscess-like nodules protruding from the surfaces of the lungs. Sometimes these flukes cause adhesions between the lungs and chest walls, ulcers or tuberculosis-like lesions. Heavy infestations may cause serious trouble and death.

The eggs of the lung flukes are passed into the windpipe, coughed up, swallowed and discharged with the manure. The eggs only incubate in wet places and the young flukes first require snails and then crayfish in which to grow. Pigs pastured on wet land, where they may find and eat crayfish, are subject to infestation with these parasites. The feeding of pigs with leftover fishing bait may also be a source of infestation.

Lung flukes occur mostly in wild animals such as mink, and other stream and lakeshore feeding creatures. The flukes are encountered chiefly in pigs of the western and gulf states, but may occur anywhere under suitable conditions. Besides being found in the lungs, these worms are sometimes present in the liver, brain or spinal cord.

Swine Lungworms *(Metastrongylus apri)* are slender white worms which grow to a length of almost two-and-a-half inches. They resemble threads of cotton and live in the windpipe or deep in the lights (lungs). Young pigs are most susceptible to these worms; older pigs become partially resistant to them.

Lungworms cause loss of condition and stunted growth. Infested animals cough and may develop haemorrhages, bronchitis, pneumonia and nodules in the lungs which are not unlike those caused by tuberculosis. The branches of the windpipe become filled with mucous upon which the worms feed. In long-

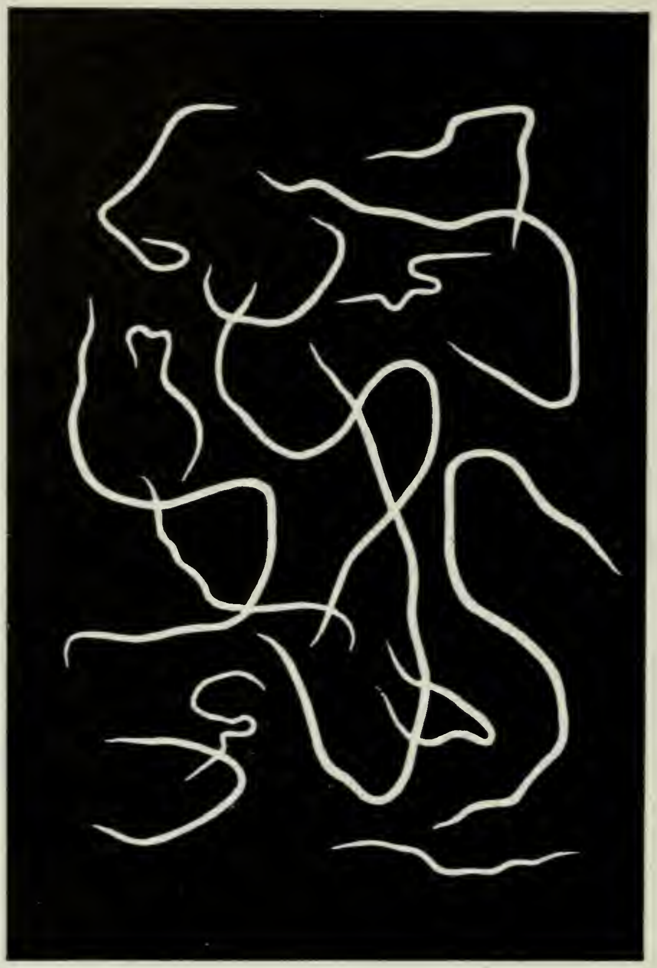

Fig. 15. Lungworms, *Metastrongylus apri* (Gmelin, 1790). Natural size.

standing cases the tips of the lungs become greyish and hard. Bacteria may make the condition worse.

Lungworm eggs, or hatched young worms, are coughed up, swallowed and are passed from the animal with the dung. Earthworms, especially those kinds found near manure piles, feed on pig manure and become infested with young swine lungworms. Pigs get lungworm disease only by eating earthworms so infested.

The virus of swine influenza is kept alive for the two or three years in young lungworms.

Besides the above lungworms, there are two others which may be found in pigs–*(M. pudentotectus)* which is fairly common but only about half the length of the above worms, and *H. salmi* which is seldom seen.

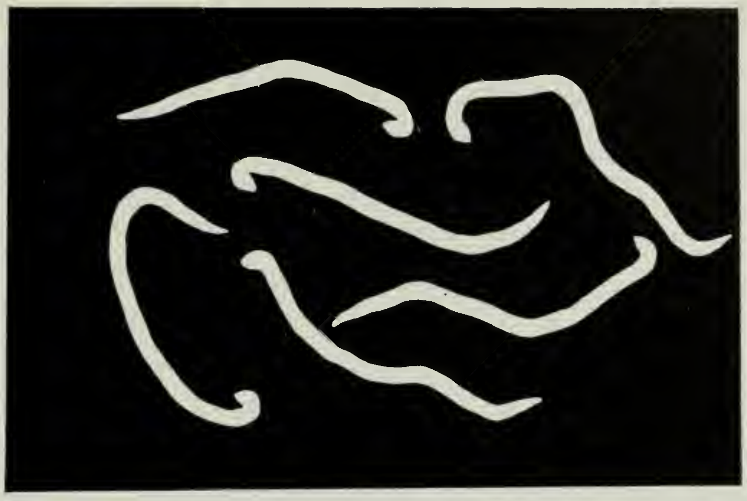

Fig. 16. Kidney Worms, *Stephanurus dentatus* Diesing, 1839. Natural size.

PARASITES OF THE UROGENITAL SYSTEM

Swine Kidney Worms *(Stephanurus dentatus)* are fairly thick and vary in length from three-quarters of an inch to an inch and three-quarters. They have a mottled appearance. Losses caused by these worms in one packing plant were estimated at $80,000 annually. They are, however, most common in warm southern countries and less likely to be found in areas where there are heavy frosts.

The eggs of kidney worms are passed out of the body with the urine and develop in moist shady places. The young worms will climb up the stems of plants and grasses and may find their way into pigs when feeding or by burrowing through the skin, on which nodules may appear at the sites where the worms have entered.

While wandering through the bodies of pigs, the growing worms cause a great deal of damage producing inflammation, abscesses, scars and adhesions. The worms spend two or three months feeding and wandering in pigs' livers. Sometimes the worms get into the spinal cord and cause paralysis. The burrows of kidney worms are found in the liver, lungs and muscles over the back but chiefly in the fat around the kidneys. Some of the burrows open into the tubes running between the kidneys and the bladder and through such passages the eggs are passed into the urine.

Occasionally swine kidney worms are found in cattle and horses.

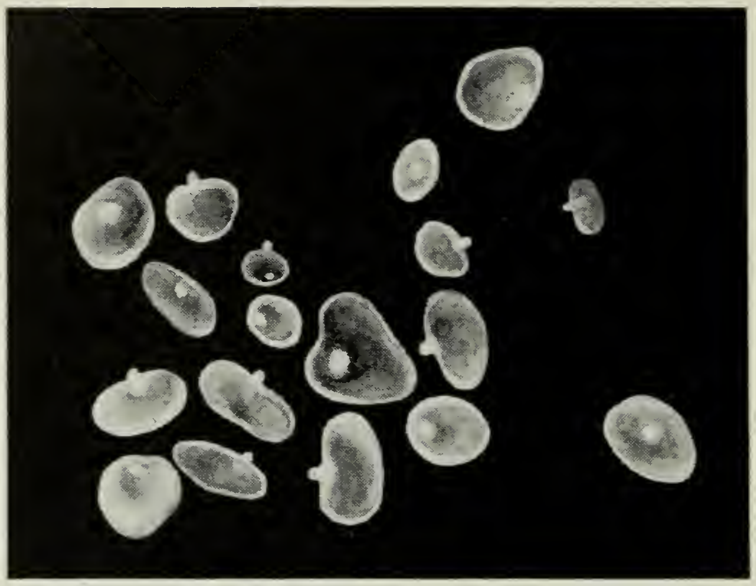

Fig. 17. Pork Bladder Worms, *Cysticercus cellulosae,* larvae of the human armed tapeworm *Taenia solium* Linnaeus, 1758. Natural size (Adapted from U.S.D.A. Farmers Bulletin No. 1787).

PARASITES OF THE MUSCLES

Pork Bladder Worms or Pork Measles *(Cysticercus cellulosae)* are slightly larger than grains of wheat. The single whitish spots seen through the walls of the bladders are tapeworms' heads. These worms, often in large numbers, are embedded in the muscles chiefly of the neck, cheeks, shoulders and tongue. They live also in the walls of the heart, liver, lungs, brain and even in the eye of a heavily infested pig.

The mature forms of the worms are found only in people who have eaten the bladders in rare or uncooked pork products. The worms in man are the well-known pork or armed tapeworms *(Taenia solium)* which attain a length of 15 or 20 feet in the human intestine. The worms are like long chains, links of which, filled with many eggs, are continuously breaking off and passing out of the body. Large sections of these worms may be seen caught in the grids of the sewage disposal plants of cities. On the farms it is through using the contents of out-houses for fertilizer or otherwise giving pigs the opportunity to forage on ground contaminated with human dung that the pigs get pork bladder worms.

After pigs have swallowed the eggs of these tapeworms the eggs hatch and burrow through the intestine on their way to the muscles. Three weeks later the bladders are large enough to see. At this stage butchers name the condition "wet measles". In time the bladder worms die and become dry and hard like cement whereupon the term "dry measles" is used to describe flesh so diseased.

A few bladder worms wandering and growing in pigs will cause no noticeable signs of ill health. When many are swallowed at one time pigs will suffer from fever, heavy breathing, diarrhoea and may die within three weeks. The flesh from pigs which survive is unfit for food and often whole carcasses must be condemned by meat inspectors.

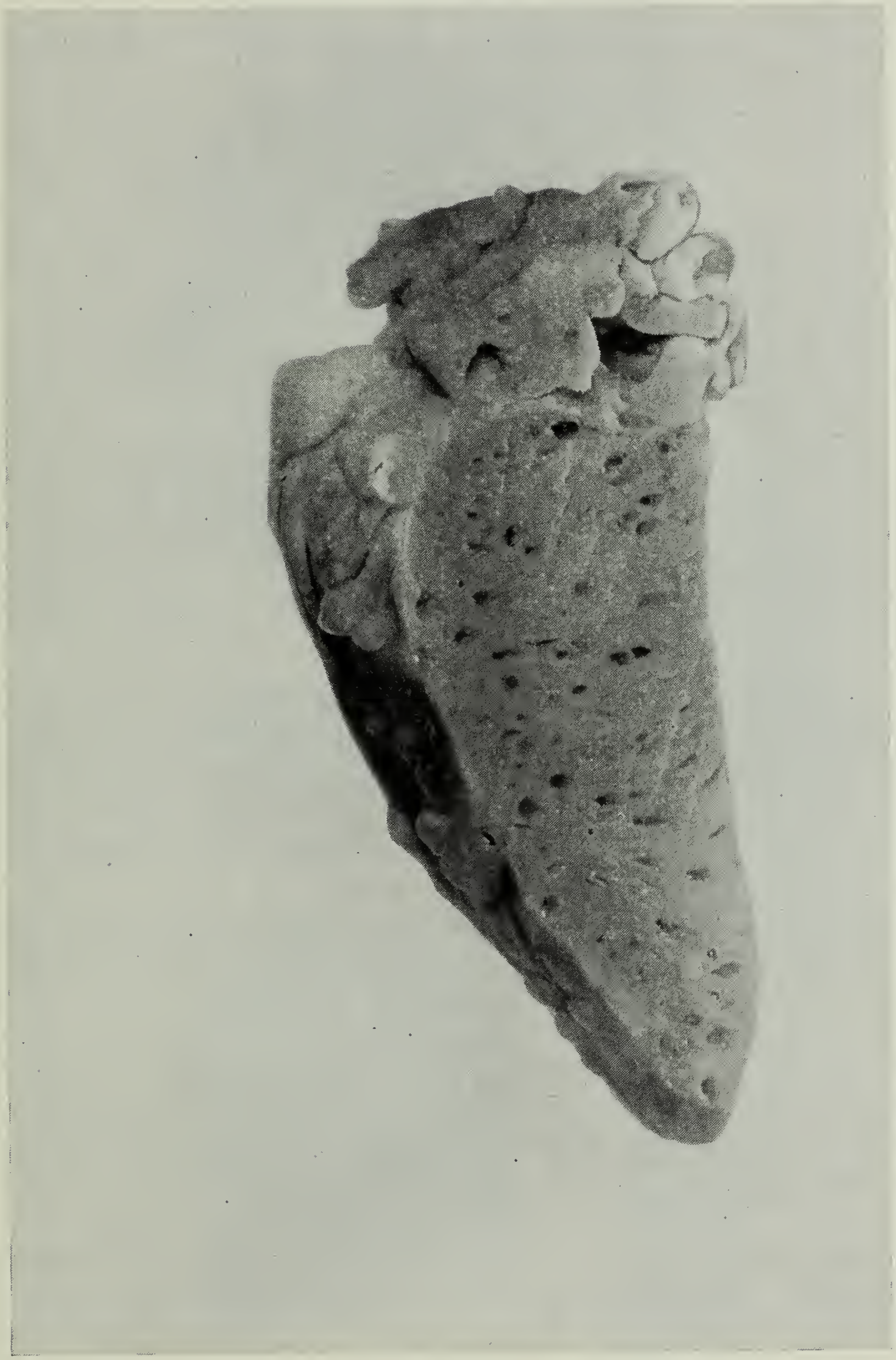

Plate IV. Section of pig's heart infested with numerous larval tapeworms. Such worms, dissected out from the heart, are shown in Fig. 17.

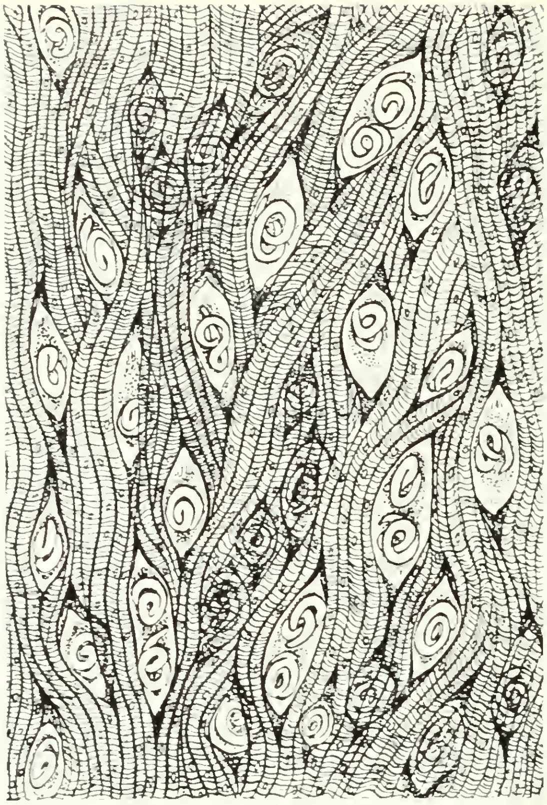

Fig. 18. Garbage Worms, *Trichinella spiralis* (Owen, 1833), embedded in pork. Highly magnified.

GARBAGE WORMS, also named MUSCLE WORMS or TRICHINA WORMS *(Trichinella spiralis)* not only live in the flesh of pigs and flesh-eating animals but also in man in whom they cause the dreaded and sometimes fatal disease trichinosis. There is reason to believe that Moses forbade the Israelites from eating pork to protect them from this disease.

Garbage worms are so small in all their stages of development that they can be seen clearly only when magnified. Unlike all other swine worms so far described, the garbage worms spend no part of their lives on the ground or outside the bodies of flesh-eating animals. The worms are spread from animal to animal only by eating each other's flesh, and to man by eating rare or insufficiently cooked, smoked or dried meat, especially pork such as is used in certain types of uncooked summer sausages. Pigs usually get these worms when fed pork scrap in uncooked garbage. They may get the worms also by eating the carcasses of rats.

Small portions of infested meat not uncommonly contain many hundreds of invisible worms coiled up in the muscle cells. When such meat is eaten the young worms escape into the intestine, burrow into the gut wall, and there produce great numbers of young which find their way into the blood and thence to the muscles. Female worms are each capable of producing up to 1500 young during a lifetime of two or three months, and an ounce of pork may contain up to 100,000 young worms.

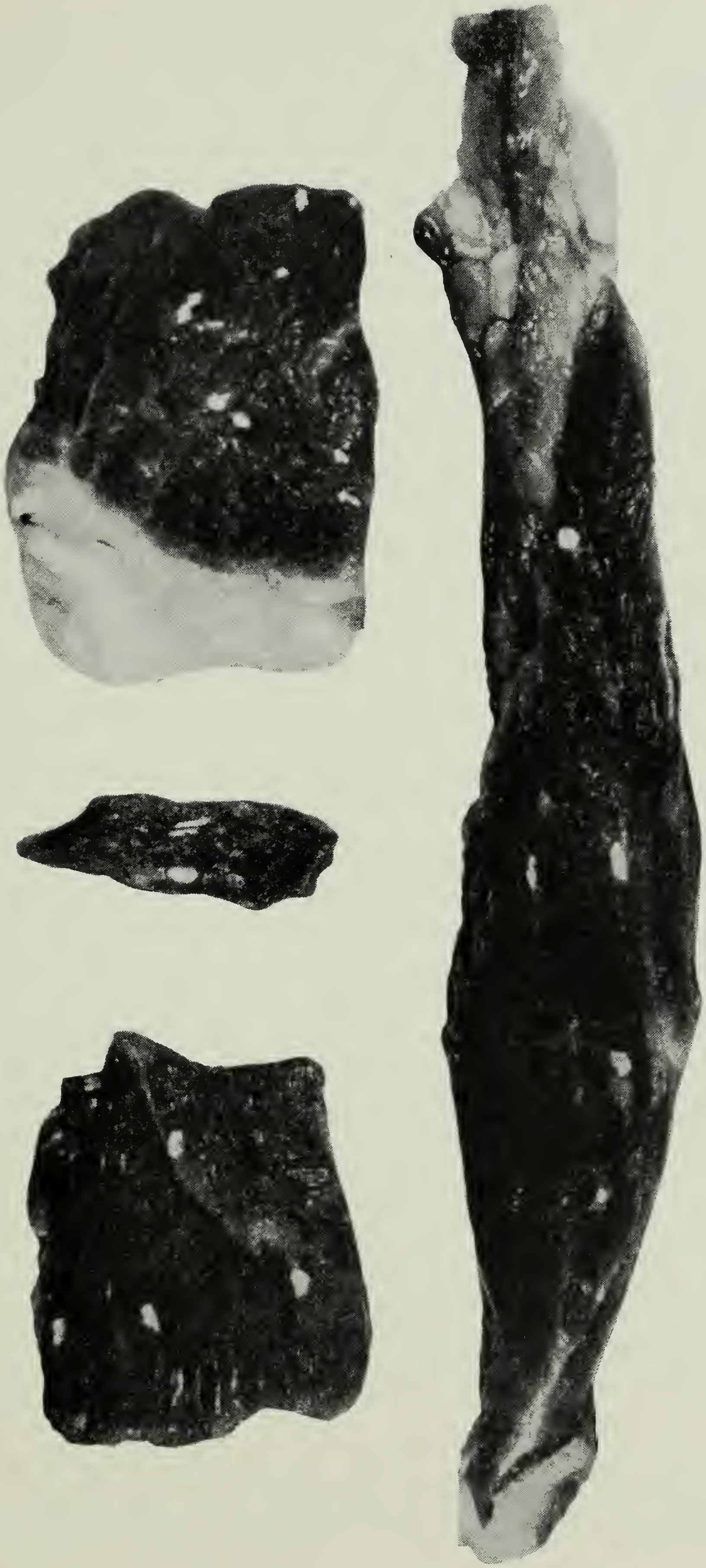

Plate V. Pieces of pork infested with muscle fungus, *Sarcocystis miescheriana* Kuhn, 1865. Reduced from natural size. The white bodies embedded in the flesh are Miescher's sacs.

When pigs, other animals, or people eat uncooked meat containing these worms, if the number of worms swallowed is small, few signs of disease will show — perhaps only tiredness and some aching pains. When many worms are swallowed there will be first a feeling of illness, then vomiting, diarrhoea, pains in the bowel, weakness, twitching of muscles and swelling of the face and eyelids, stiffness, difficult breathing and loss of condition. Nine or ten days later pain increases in the legs, arms and abdomen. Fever, pneumonia and anaemia may develop. Usually in hopeless cases, between the fourth and sixth week after getting the worms the victims die. In other cases the symptoms gradually decrease as the migration of young worms reaching the muscle ceases. In recovered cases the garbage worms lie dormant in the flesh. If they are not eaten by some animal or person, the worms eventually die and become like grains of sand embedded in the muscles.

In countries where the garbage feeding of pigs is licensed and controlled, only occasional outbreaks of this disease in people and pigs occur; in other countries, where garbage is fed uncooked, the disease is quite common. A survey made in recent years in a North American country indicated that one in every six people, at some time in their lives, had been infested with garbage worms.

PORK MUSCLE FUNGI *(Sarcocystis miescheriana)* produce a disease now believed to be caused by a plant parasite. When fully developed, the parasites are whitish in colour, firm and resemble grains of oats embedded in the flesh. Each body when ripe is filled with many minute banana-shaped spores. This disease is most often seen in pigs fed uncooked garbage containing pork scraps.

When pigs devour infected meat the spores are passed in their manure or urine two weeks later and pigs fed these spores will also contract the disease. Rats and mice may play a part in its spread. Pigs infected experimentally with large numbers of muscle fungi vomit, lose their appetites and suffer from diarrhoea and paralysis. Such animals are unthrifty and stiff, their kidneys enlarged and stomachs and intestines congested. Whole carcasses are condemned as unfit for human food when pork muscle fungus disease is present. The disease must not be confused with the "dry measles" which has already been described under the heading of pork bladder worms.

PREVENTION OF PARASITISM

The most practical, and economical method of curtailing losses from parasitic infestations in swine is to prevent the animals from becoming infested.

The following recommendations, although they involve work and trouble, will amply repay the hog producer who practises them, by protecting his stock from parasitism and, to a certain extent, from other diseases. The producer is usually further rewarded by the increased gains and profits which accrue as a result of safeguarding his animals through sanitation.

Control Measures for Large Intestinal Roundworms

It has been demonstrated by the United States Bureau of Animal Industry that, on farms where worm control is practised through sanitation, litters are of more uniform size and pigs are ready to market two months earlier than is the case on farms where sanitation is neglected. In the former case a greater number of pigs is raised also.

The method developed by the Bureau is the McLean County System of Swine Sanitation. The system has stood the test of time and is widely practised. Originally it was planned to reduce common roundworm infestations, but, with certain modifications, it is effective also in preventing heavy and harmful infestations of kidney worms, lungworms, stomach worms, hookworms, nodular worms, diarrhoea worms, whipworms and others which individually or collectively cause disease.

The basic principle of the system is to protect young pigs, during the first several months of their lives, from becoming infested with worm eggs or young worms which may be present in great numbers in dirty pens, hog lots or pastures previously used by other pigs.

The first step is to prepare sows just prior to farrowing by scrubbing them with soap and warm water to remove mud, filth and worm eggs. Farrowing pens are cleaned with a stiff broom, using lye and boiling water (1 lb. lye to 1 gallon of water.) The floors, walls, guard rails and troughs are cleaned. Particular attention is paid to cleaning cracks and crevices. The pens are rinsed out, finally, with boiling water. Pens, once cleaned, should not be entered more than is necessary, and then only when clean footwear is worn to avoid taking in worm eggs on the boots.

Ten days after farrowing the sows and litters are moved on sleds or wagons*, to clean pastures** where they are kept four months during which time the growing pigs acquire resistance to heavy roundworm infestations. The sows are removed following weaning.

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* Any extension of the ten-day period will nullify the value of the system as it is based on the time taken for roundworm eggs to incubate and become infective. The use of sleds or wagons is to avoid herding clean pigs over contaminated ground and is an essential part of the system.

**In Ontario, where winter litters are raised and pasture seasons are short, the alternative is to remove pigs to freshly cleaned pens, treated as described for farrowing pens.

Control Measures for Kidney Worms, Stomach Worms, Nodular Worms. Hookworms And Whipworms

Modifications of the McLean County System are based on the knowledge that sunlight and dryness destroy the eggs and young of certain worms commonly in the ground. Kidney worms, stomach worms, nodular worms, hookworms, whipworms, lungworms, and others, are amongst those affected.

The modifications consist of placing pigs on clean pastures, with five-foot ploughed strips on three sides and a thirty-foot ploughed strip where farrowing pens, shelters, food troughs and water troughs are to be placed. These bare areas are kept free of shade, vegetation and rubbish, and must be cultivated frequently. (Strips should be ploughed at the time of seeding the pastures.) Much of the manure and urine will be passed on the bare areas and thus exposed to sunlight and drying. Drainage of wet places is desirable.

Separate feeding places are used for sows and, some distance away, feeding creeps are provided for younger pigs. Colony houses, when used, should be moved frequently to clean ground.

Control Measures for Gullet Worms, Thorny-headed Worms and Lungworms

To prevent pigs from becoming infected with worms requiring intermediate hosts (earthworms, dung beetles, cockroaches, etc.), piles of pig manure must not be permitted to accumulate. Manure should be spread on land upon which it is not intended to raise swine. Dryness and sunshine, above all, will make conditions unfavourable for many of these creatures. The removal of rubbish will reduce their hiding places. Poultry ranging with swine will destroy many insects and worms.

Earthworms, which are required as intermediate hosts for swine lungworms, and the white grubs, required by the thorny-headed worms, cannot be exterminated practically*. Pastures, once contaminated with these parasites, may remain dangerous to pigs for two or three years. Once ground is known to be contaminated it should be ploughed in the autumn, cropped, and if possible not used again by swine for three years. A degree of protection may be obtained against lungworms and thorny-headed worms by discouraging pigs from rooting; this is done by ringing their noses and feeding them adequately before turning them out to forage. On farms where swine influenza has occurred, it must be remembered that the disease is carried over from year to year on lungworm-infested ground.

Provided they are kept clean, pens with concrete, or other impervious flooring, are less likely to be a source of parasites than poorly drained, unfloored pens. Such quarters, when available, should be reserved for very young and growing pigs to give them protection during the age when they are most susceptible to infestations.

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* White-grub control by new insecticides, provided they are nontoxic to swine and not too costly, may have possibilities.

The practices recommended under the heading of modifications of the McLean County System will help to reduce the incidence of worms transmitted by intermediate hosts.

Control Measures for Intestinal and Lung Flukes

The snails which transmit flukes may be controlled by drawing small bags of bluestone (copper sulphate) about pasture pools until the water becomes robins' egg blue in colour. For marsh areas, one part of bluestone is mixed thoroughly with four parts fine sand and the mixture broadcast at the rate of 100 to 150 lbs. to the acre of bog. Draining marshy places or fencing off, to exclude livestock, is also helpful. Streams must be treated by a special formula method to allow for the rate of flow and other factors.

Bluestone should be used with care as it is poisonous to game and other fish as well as for snails. Farm animals must be kept away from treated areas for at least a week or until after a fairly heavy rain.

Control Measures for Water Balls, Hydatids and Measles

Prevention of infestations with common larval tapeworms (water balls and hydatid worms) consists largely of controlling the adult tapeworms in farm dogs by regular treatments, when indicated, with standard tapeworm remedies, and by preventing dogs from gaining access to raw slaughter-house trimmings and offal from which they become infested in the first place.

Communities can reduce the population of stray dogs by enforcing dog tax laws. The number of foxes and wolves running over farm lands might be reduced by offering bounties. Dead animals should be deeply buried, covered with quicklime or burnt to prevent members of the dog tribe devouring the water balls in the carcasses.

Pork bladder worms (measles) appear in pigs only when such animals have had access to ground fertilized with, or contaminated by, human excrement. Prevention of infestation is through the construction and use of sanitary toilets.

Control Measures for Protozoans, Garbage Worms, Muscle Fungi and Parasites Transmitted from Pigs to Man

Hog producers, butchers and other persons may protect themselves from the occasional infections and dysenteries possibly caused by amoebae and balantidia by practicing personal cleanliness. The hands should be thoroughly washed and scrubbed before meals. Fertilization of truck crops with pig manure must be avoided to prevent the transmission of these parasites to man.

Coccidiosis in pigs may be prevented and controlled to a certain extent by the application of the McLean County System of Swine Sanitation and its modifications.

Garbage worm disease (trichinosis) and the transformation of the pork bladder worms (measles) into the armed tapeworms of man can be most successfully guarded against by the thorough cooking of all pork cuts. Such meats should always be boiled, roasted or fried until no trace of red flesh remains. Certain methods of smoking or pickling meats do not always ensure destruction of the worms they may contain. Where suitable facilities exist, such as in large packing plants, curing or freezing for appropriate lengths of time at suitable temperatures protects the consumer against infection from such pork products as those which are traditionally eaten uncooked or rare. The dangers of man acquiring garbage worm disease is further lessened in well organized plants through the policy of mixing the meat for sausages from large numbers of pigs. *Meat inspection stamps do not indicate that pork is free from the invisible trichinae worms.* The greatest danger of infection is in home butchering, where a single infected pig may infest a number of persons at barbecues or under other circumstances where the meat is not rendered harmless by thorough cooking.

Pigs may be protected from infestations with garbage worms and pork muscle fungus disease by ensuring that all garbage fed is thoroughly cooked and rats and mice eliminated from the premises by the use of safe rodenticides and traps.

TREATMENTS FOR PARASITES

If, through various circumstances, pigs fail to make gains, become ill or commence dying, the possibility of parasitism being the cause should be considered. Other disease factors must be eliminated. Sick pigs should be treated only for parasites when definite diagnoses of parasitism are made by symptoms shown and by microscopic or post-mortem examinations.

Contraindications for Treatments with Worm Remedies

Pigs with high temperatures (over 103° F.), secondary bacterial infections, anaemia or marked weakness, are not likely to tolerate worm medicines. Usually brood sows should not be wormed immediately before or after farrowing. (The best time to treat sows is shortly after they are bred.) Very young pigs will not always tolerate worm remedies. Care must be used in the choice of drugs for pigs under four weeks of age. Drugs given to pigs heavily infested with roundworms sometimes cause the worms to collect in masses and fatally obstruct the bowels.

Hygiene, Feeding and Nursing

When parasites are suspected of being the cause of disease, it is necessary to reduce further intake of eggs, young worms or protozoans by removing the sources of infestation. Pens must be cleaned thoroughly or pigs moved to temporary quarters on clean ground where they are provided shelter, ample dry bedding and adequate rations, including any minerals or vitamins they may have been lacking in their diets. The use of antibiotic foods may also prevent or control secondary bacterial infections.

The health of markedly sick pigs may be improved sometimes prior to treatments by good nursing, the administration of tonics and treatment of symptoms such as those of bronchitis, pneumonia, anaemia, diarrhoea or constipation, etc.

Preparation for Treatment with Worm Remedies

For the administration of some drugs, animals require preparations which consist, in the case of intestinal parasites, of partially emptying the stomach and bowels of food by starvation. This is necessary to prevent undue dilution of drugs used, and to expose the worms to their action. It is not necessary in all cases, and in some is undesirable. The correct procedure to follow is usually indicated in printed directions accompanying worm remedies; these directions should be read carefully and meticulously followed. Dosages of drugs must be varied according to the ages and condition of pigs requiring treatments. It is wise to treat a few animals before administering drugs to whole herds.

Individual Treatments with Worm Remedies, Administration of Medicines and Methods of Restraint

Individual treatments ensure correct, safe and effective doses of medicine being given to all pigs treated. To facilitate treatments of this type, hurdles, catching gates, pig catchers or snares are required. Worm remedies are administered usually in the form of drenches or capsules given with balling guns, forceps, or stomach tubes. Suitable mouth gags are required.

The successful administration of capsules to pigs, or the passing of stomach tubes is dependent upon introducing the objects into the gullets, and in avoiding the windpipes and pharyngeal recesses. These latter structures are small blind pouches, and each pig has one immediately above the opening into the gullet. The accidental introduction of capsules into these pouches may do much harm or prove fatal. (See Plate VI).

Quite large pigs may be suitably restrained by sitting them on their haunches and holding them up by the forelegs with the backs of their bodies wedged between the restraining person's knees. Small pigs are restrained in a similar manner, but with their hind feet just touching the ground. (See Plate VII). Boars, sows and pigs too large to manage by hand must be restrained with special tackle; most drugs, however, though not all, are given to them with their food.

A taste of grain given to pigs immediately before and after treatment stimulates salivation. Kindness to hogs, from the time they are small onwards, will make them more easy to handle and treat.

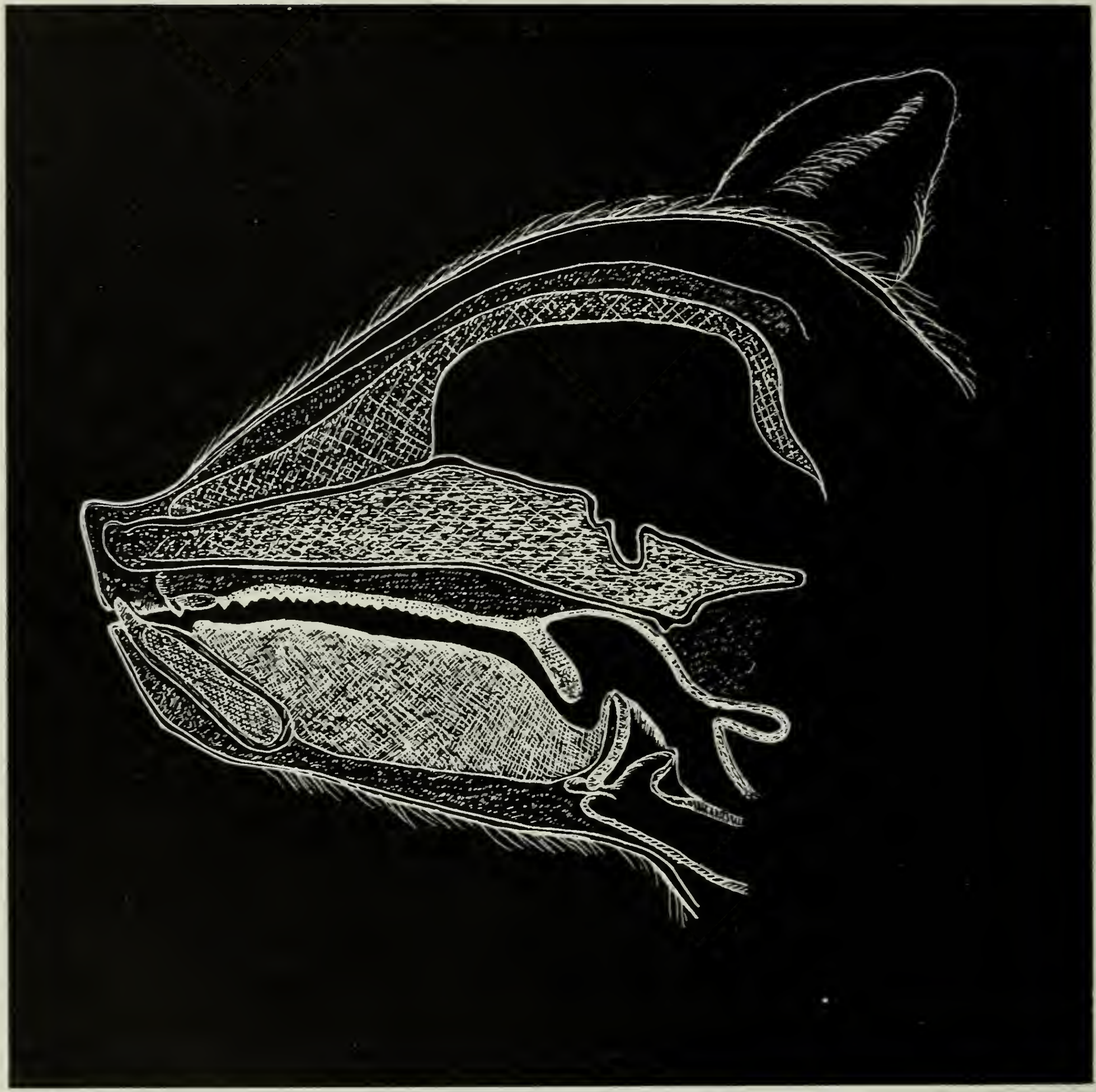

Plate VI. SECTION OF A PIG'S HEAD. The position of the pharyngeal recess at the back of the throat is shown in the lower right hand corner of the diagram. Below the recess is the opening into the gullet. In front and below the gullet and recess is the larynx or opening into the windpipe.

SODIUM FLUORIDE is from 93 to 95 per cent effective against immature and mature large intestinal roundworms and stomach worms (Ascarops and Physocephalus) in swine. The drug is not effective against thorny-headed worms, nodular worms or whipworms. When necessary, pigs may be treated with sodium fluoride between eight and sixteen weeks of age and again when between four and six months old. The drug should not be used as a worm remedy on breeding stock in herds where treatments have to be repeated frequently.

Commercial grades of sodium fluoride contain 73 per cent of the chemical, while other more highly refined preparations may contain 95 per cent pure sodium fluoride. When the latter preparations are used dosages have to be reduced in proportion. Suitable preparations of the drug are available, under trade names, in packages made up especially for swine. These packages of the powder, approved and licensed for sale in Canada, should be used in accordance with the directions on the labels.

No fasting or purging is necessary prior to or after treatment with sodium fluoride. It was at first recommended to be used at the one per cent level, but it is safer to use at the three-quarter of one per cent level. Three-quarters (¾) of a lb. of sodium fluoride is mixed with one hundred (100) lbs. of dry ground grain, the total amount prepared being that which the pigs will consume in one day. Half the amount of the medicated food is given usually in the morning and the balance in the evening feedings.

Sodium fluoride must not be given with wet mashes or in swill. It is highly poisonous to man and other animals. Poisoning symptoms in pigs are vomiting, soft *faeces, diarrhoea,* loss of appetite and death. Care should be taken to keep the chemical out of skin wounds.

OIL of CHENOPODIUM or OIL of AMERICAN WORMSEED has been long used for large intestinal roundworm control in pigs. Experimentally, it has been demonstrated to remove 74 per cent of the worms. The administration of chenopodium is preceded by starving the animals for 18 to 24 hours. The dose is one-half to one fluid dram (2-4 cc.) for a 100 lb. animal, or in proportion.

Chenopodium is most effective when administered in individual doses by syringes, stomach tubes, or capsules. It may also be given in wet mashes to small groups of not more than six pigs. Mass treatments save labour, but make it difficult to control the amount which individual pigs receive.

The administration of chenopodium is accompanied or followed by two fluid ounce (60 cc.) doses of castor oil for each 100 lb. body weight. Additional cathartics should be given if the bowels do not move within an hour.

A useful mixture combining the worm remedy and purgative into a single dose, is composed of oil of chenopodium five parts, and caster oil 95 parts. The dose, after an overnight fast, is two to three teaspoonfuls for five-week-old pigs; six to eight teaspoonfuls for eight-week-old pigs; three to four tablespoonfuls for 12-week-old-pigs, and, seven tablespoonfuls for adult pigs. Suitable commercial preparations are also available.

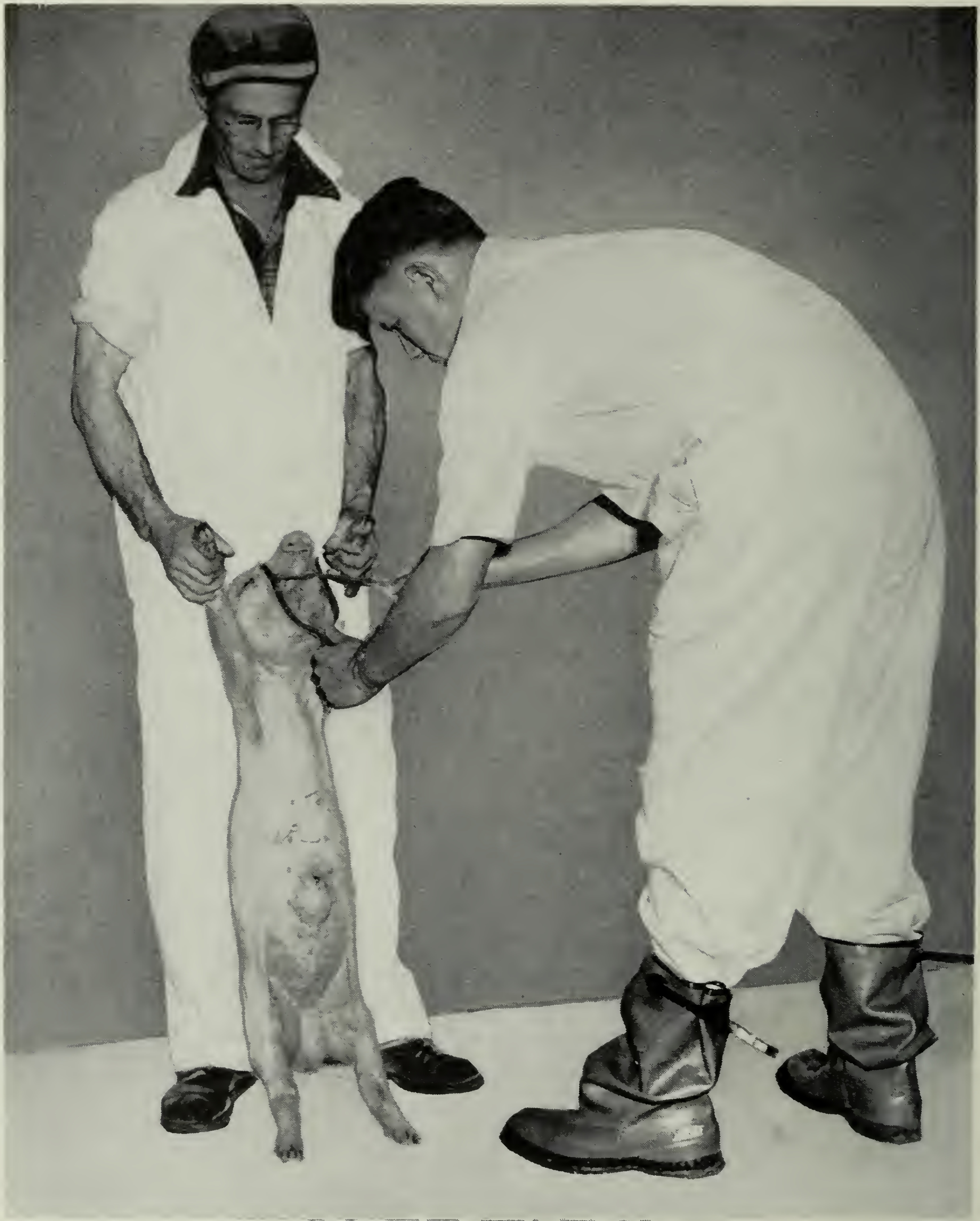

Plate VII. WORMING RESTRAINT FOR PIGS

The maximum dose of oil of chenopodium for any pig should never exceed 12 cc. Oil of chenopodium should not be given to pregnant sows within 60 days of farrowing. Water and feed are not given until three hours after treatment.

SANTONIN is a relatively safe drug and not an irritant to the alimentary canal. When given with, or followed by purgatives, it will remove a percentage of the large intestinal roundworms. The drug may be added to the feed and given over a period of time. The chief objection to santonin is its high cost.

The single dose of santonin for pigs is from five to ten grains. It must be followed by a dose of Epsom salt with the next meal. (The dose of Epsom salt for a mature pig is three ounces.) For each 100 lb. live weight, eight grains santonin and five grains calomel may be given twice daily, mixed in the feed for 10 consecutive days. After short intermissions this course of treatment is repeated for a second and, if necessary, a third 10-day period.

PHENOTHIAZINE is 92 per cent effective against nodular worms, but only to variable degrees against large intestinal roundworms in swine. The drug has but little effect on immature roundworms so its use is best confined to pigs three months or more old. It should not be given indiscriminately to pigs under four weeks of age or to sows near farrowing time.

Phenothiazine may be given in capsules or mixed with the feed. There also are other forms in which this drug is available. For individual treatments the weights of pigs should be known and doses be measured accurately. Doses are five grams for 25 lb. pigs; eight grams for pigs weighing from 25 to 50 lb., 12 grams for 50 to 100 lb. pigs, and 20 grams for animals weighing between 100 and 200 lb. For heavy breeding stock phenothiazine may be given at the rate of 0.1 gram per lb. body weight and the full dose for individuals given thoroughly mixed in a lb. of tankage. Thirty grams is the maximum dose for pigs weighing over 200 lb. For mass treatments one-quarter lb. of phenothiazine, mixed with sufficient food for one meal, treats 35 thirty-pound pigs, 25 forty-pound pigs or 20 fifty-pound pigs.

Mass treatment with phenothiazine of large groups of pigs may lead to loss as some pigs will get more than the intended share of the medicated feed. When it is decided to administer phenothiazine to worm-infested pigs by mixing the drug in the feed, the following facts should be kept in mind: (1) the mixture of phenothiazine and feed should be "stiff," not sloppy; (2) the number of pigs in the pen at one time should not exceed six; (3) the pigs should all be the same size or weight and have equal fighting ability to insure each one getting an equal share; (4) feed troughs that are sectioned to prevent greedy feeding are an aid in insuring each pig an equal share; (5) the medicated feed should be placed in the trough in such a way to permit all pigs in the group to start at exactly the same time; (6) it is not necessary to starve or withhold feed from pigs that are listed for treatment with phenothiazine as pigs will take it readily in their usual feed; (7) the medicated feed should be evenly distributed in the feed trough before the pigs are admitted. Trouble is likely to follow any carelessness that will permit overdosing with phenothiazine; (8) the correct amount of phenothiazine must be thoroughly mixed with the feed and fed at once; (9) pigs should not be exposed to the sun for 24 hours following treatment with phenothiazine.

CARBON TETRACHLORETHYLENE is effective against large intestinal roundworms and hookworms. It is better suited to pigs under 50 lb. in weight than either oil of chenopodium or phenothiazine.

The drug is administered in capsules, by those skilful enough to perform the task. The dose for pigs weighing up to 50 lb. is 1 cc.; for 100 lb. 2 cc.; 200 lb. 5 cc. and 500 lb. 10 cc. Capsules, which burst in the mouths, or lodge in the pharyngeal recesses, (see Plate VI), may cause death by asphyxiation.

CARBON DISULPHIDE, HEXYLRESORCINOL and SULPHONAMIDES, are effective respectively in the control of thick and red stomach worms, nodular worms and coccidia. These drugs, however, together with phenothiazine and carbon tetrachlorethylene, should be used only on a veterinary surgeon's advice.

SKIM MILK, when available in sufficient quantities, will remove the thick stomach worms *(Ascarops strongylina)*, large intestinal roundworms and whipworms. The milk is fed at the rate of eight to ten gallons per day, or at intervals of two weeks until purging is produced. Good gains will be made regardless of the purging. It requires four to five days of such treatment to eliminate from 61 to 100 per cent of whipworms.

MISCELLANEOUS

No satisfactory drug treatments exist to eradicate the following parasites in swine: larval tapeworms, gullet worms, thorny-headed worms, whipworms, lungworms, garbage worms, kidney worms or pork muscle fungi. All these infestations, however, may be reduced or controlled by sanitation.

BULLETIN 497 DECEMBER, 1953

SOIL MANAGEMENT
AND
FERTILIZER USE

RECOMMENDATIONS OF
THE ADVISORY FERTILIZER BOARD FOR ONTARIO

A fertile soil, well managed.

ONTARIO DEPARTMENT OF AGRICULTURE
PARLIAMENT BUILDINGS, TORONTO, CANADA

CONTENTS

THE ADVISORY FERTILIZER BOARD, FUNCTIONS, MEMBERSHIP 3

SOIL MANAGEMENT
PAGES 5 - 30

Air and Water 5
The Mineral Part of Soil 7
Organic Matter 7
Legumes 10
Manures 11
Soil Micro-organisms 14
Cultivation 15
The Inherent Fertility of Soils 17
Losses of Plant Food from the Soil 17
Soil Reaction, or pH of Soils 22
The Nutrient Elements 23
Soil Testing 29

FERTILIZERS
PAGES 31 - 36

Origin and Use of Fertilizers 31
Higher Analyses Fertilizers 31
Nitrogen Equivalent Table 32
Methods of Applying Fertilizers 32
Terms Frequently Used in Fertilizer Work 35
Fertilizer Analyses 36

RECOMMENDATIONS FOR SPECIFIC CROPS
PAGES 37 - 66

Cereal, Hay and Pasture Crops 37
Intertilled Crops 43
Tobacco 47
Flue-cured Tobacco 49
Burley Tobacco 49
Dark Tobacco 49
Fruits 50
Tree Fruits 50
Grapes 53
Small Fruits 54
Vegetables 56
Market Garden Crops on Mineral or Upland Soils 59
Market Garden Crops on Organic Soils 60
Canning Crops 62
Turf and Lawn 64
Fertilizing Fishing Waters 66

REFERENCES 67

THE ADVISORY FERTILIZER BOARD FOR ONTARIO

CONSTITUTED BY ORDER-IN-COUNCIL OF THE ONTARIO GOVERNMENT, APPROVED BY THE HONOURABLE, THE LIEUTENANT-GOVERNOR, DATED FEBRUARY 9TH, 1934

The functions of the Board are:

(a) To bring together in conference from time to time farmer-users, government officials and manufacturers in order to discuss problems of fertilizer usage.

(b) To examine experimental data from all reliable sources having to do with the use of fertilizers and methods of application, and to make recommendations as may be justified by such data or by approved farm practice.

(c) To encourage methods of soil management and cultural practices designed to increase productivity of Ontario soils.

(d) To give due publicity to the recommendations of the Board, so that farmers may be encouraged to use recommended fertilizers in the most effective way.

MEMBERS OF THE ADVISORY FERTILIZER BOARD FOR ONTARIO

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The Earth is the Mother of us all — plants, animals, and men . . . Nature treats the earth kindly. Man treats her harshly. He overplows the cropland. overgrazes the pastureland, and overcuts the timberland. He destroys millions of acres completely . . . The flood problem insofar as it is man-made is chiefly the result of (this) overplowing, overgrazing, and overcutting of timber . . . The social lesson of soil waste is that no man has the right to destroy soil even if he owns it in fee simple. The soil requires a duty of man which we have been slow to recognize.

From Soils and Men, U.S.D.A. Yearbook of Agriculture, 1938.

The aim of agriculture must be sustained production — production and conservation together. But on both these levels, we are now failing to achieve this aim. The world is short of food and many soils are deteriorating. Some soils are declining in fertility and organic matter. Some are losing their granulation and becoming hard and massive or loose and powdery. Erosion is still taking a heavy toll. All these effects are interrelated. Loss of fertility leads to weakened plant growth. This means that the soil has a less effective cover. Then erosion removes the granular surface soil, exposing massive soil that is difficult to get into good tilth.

Efficient Use of Fertilizers, F A O Agricultural Studies.

The aim of raising crops is to feed and clothe mankind. Although continuing research is needed to gain even better control of the physical and biological factors important to crop production, the great advances in science up to now have provided the means to protect crops and to increase their yields. If full use is made of present scientific knowledge and technology for crop production in all parts of the world, great advances can be made towards building healthful lives and providing adequate diets for all. One of the strongest links in the chain of successful crop production is the efficient use of fertilizers. The farmer himself has to forge it, but he needs technical guidance and, under some conditions, economic assistance if this link is to be strongly made.

Efficient Use of Fertilizers, F A O Agricultural Studies.

SOIL MANAGEMENT
and
FERTILIZER USE

> *"The nation's natural resources — land, lakes and streams, forests and mines — exist for the benefit of all its people. Not the least among these resources are our soils, the very foundation of . . . a permanent agriculture. A flourishing agriculture is the back-bone of prosperity and social and economic progress in this country. It is a matter of some consequence as to what we are doing about this most fundamental of all resources, the soil. Are we merely farming the land for to-day or are we conserving to-day's soil for to-morrow?"*
>
> Prof. G. N. Ruhnke, Director of Agricultural Research in Ontario.

We remember that, as present owners of the soil, we are simply custodians for a brief span of time. The privilege is to be cherished, the responsibility recognized. For, "land belongs to a vast family, of which many are dead, few are living, and countless numbers are still unborn".

As a farmer, your immediate concern is how best to handle your soil for your type of farming. You have a particular concern to make soil highly productive, and continuously so. This bulletin will help you to achieve that aim.

SOIL MANAGEMENT

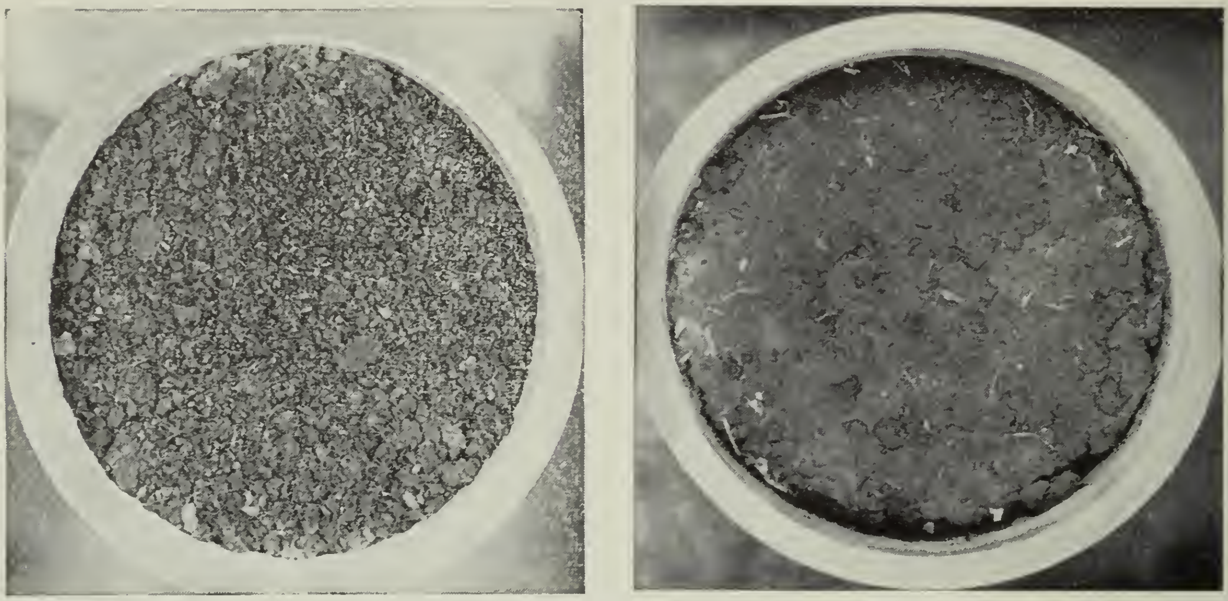
What is soil? We must first know something of the nature and composition of soil if we are to understand how best to modify it to our use by cultural and fertilizer practices.

Soil is composed of four fractions or constituents — Air, Water, Minerals, and Organic Matter. Let us briefly examine them.

AIR AND WATER

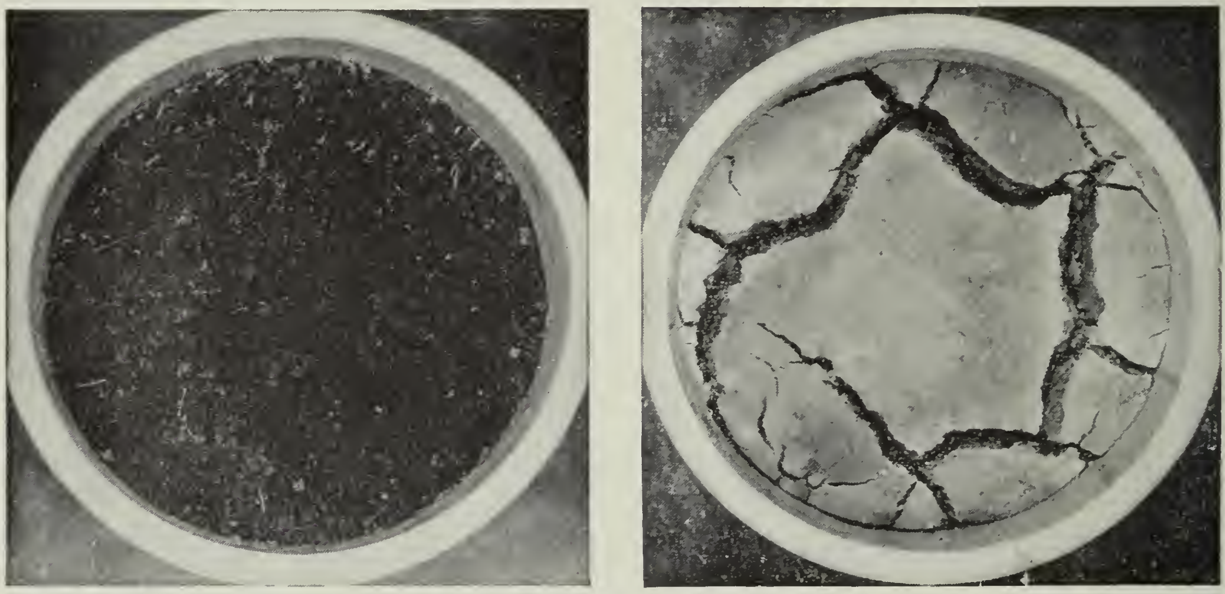
If your soil is in good tilth or physical condition it will have about one-half its volume occupied by air and water. The very small soil pores hold the water, while air fills the larger pores. When the balance between air and water is unfavorable we have either a poorly drained soil, or one that is too open and droughty. Compact, impervious soils, lacking a granular structure, drain too slowly and are poorly aerated. Often these soils respond to artificial drainage which, by removing surplus water, permits more air to circulate.

FIG. 2. ORGANIC MATTER IS THE KEY TO GOOD SOIL STRUCTURE



This soil has been in sod for years, hence is well supplied with organic matter, and has an open crumb-like structure that is not broken down even by beating rains.

Originally similar soil to that on the left, but from an adjoining field where the organic matter has been depleted by faulty management and the physical condition is very poor. You don't dare work this soil right after rains.



This well granulated, humus-rich soil, when wetted, absorbs the water readily, drains freely, yet acts like a sponge to hold a store of moisture for the crop when it needs it.

When rain hits this soil, the top layer runs together like slurry. After the sun has baked it for a few hours, it sets like concrete, and then cracks into blocks. When heavy soils are exhausted of their organic matter they are "balky" soils to work, wet or dry.

THE MINERAL PART OF SOIL

Soil, apart from air, water, and organic matter, is made up of mineral matter ranging in size from very fine clay to gravel and stones. It is the relative percentage of these stones, sand, silt and clay that determines soil *texture.*

Our "light" soils — our sands, loamy sands, and sandy loams, with their relatively high percentage of sand and gravel — are coarse-textured. As the silt and clay content increases soil texture becomes finer and we have our medium-textured soils — our loams and silt loams. The still finer-textured soils — clay loams, silty clay loams, and clays — are our heavy soils.

While coarse-textured, fine-textured, etc. may be more descriptive terms than light and heavy, yet we are used to the latter and shall use them in this text.

These soil particles cling together in groups, and it is the size, the shape, and the resistance to crumbling of these groups that determines soil *structure.* Good soil structure is as important to you in plant growth as a proper balance of plant foods. In fact plant-food shortages are, in general, easily remedied, but once you damage fundamental soil characteristics like aeration, drainage, and structure, they are repaired with difficulty.

ORGANIC MATTER

What is Organic Matter?

Soil organic matter, often loosely called "humus", is composed of plant and animal matter undergoing decay. The terms "soil organic matter" and "soil humus" are not easily defined or indeed capable of exact definition. However, briefly, you may regard soil organic matter as including such material (the main source) as dead roots, leaves, fruits, and stems of plants; carcasses of insects, worms and animals; live and dead soil micro-organisms; and various products of decomposition of dead residues. Chemically it consists of proteins, carbohydrates, fats, resins, waxes and similar compounds. Humus is an advanced stage in the decomposition of organic matter.

Effects of Organic Matter

Organic matter tends to bind loose or coarse-textured soils, open up heavy or fine-textured soils, and improve the moisture relationships of all soils. It constitutes the home and food supply of soil micro-organisms, including the nitrifying organisms. In decomposing it both liberates nutrients which are then available to your crops and reduces the loss by leaching of these nutrients. Organic matter also retards the loss of your valuable topsoil by erosion, makes cultivation easier, and allows soils to warm up faster in the spring if your drainage conditions are good.

The amount of organic matter in a soil is closely related to the capacity of that soil to retain moisture. Where organic matter increases the water-holding capacity of a soil it does not necessarily increase the amount of water which is available to plants. In coarse-textured, or light soils, the amount of available water will increase with an increase in organic matter. However, in fine-textured, or heavy soils, with their relatively high content of fine clay particles, the addition of organic matter is not likely to have much effect on the amount of water available for plant growth. If you maintain satisfactory structure in your soils, your crops will be better able to use the soil moisture.

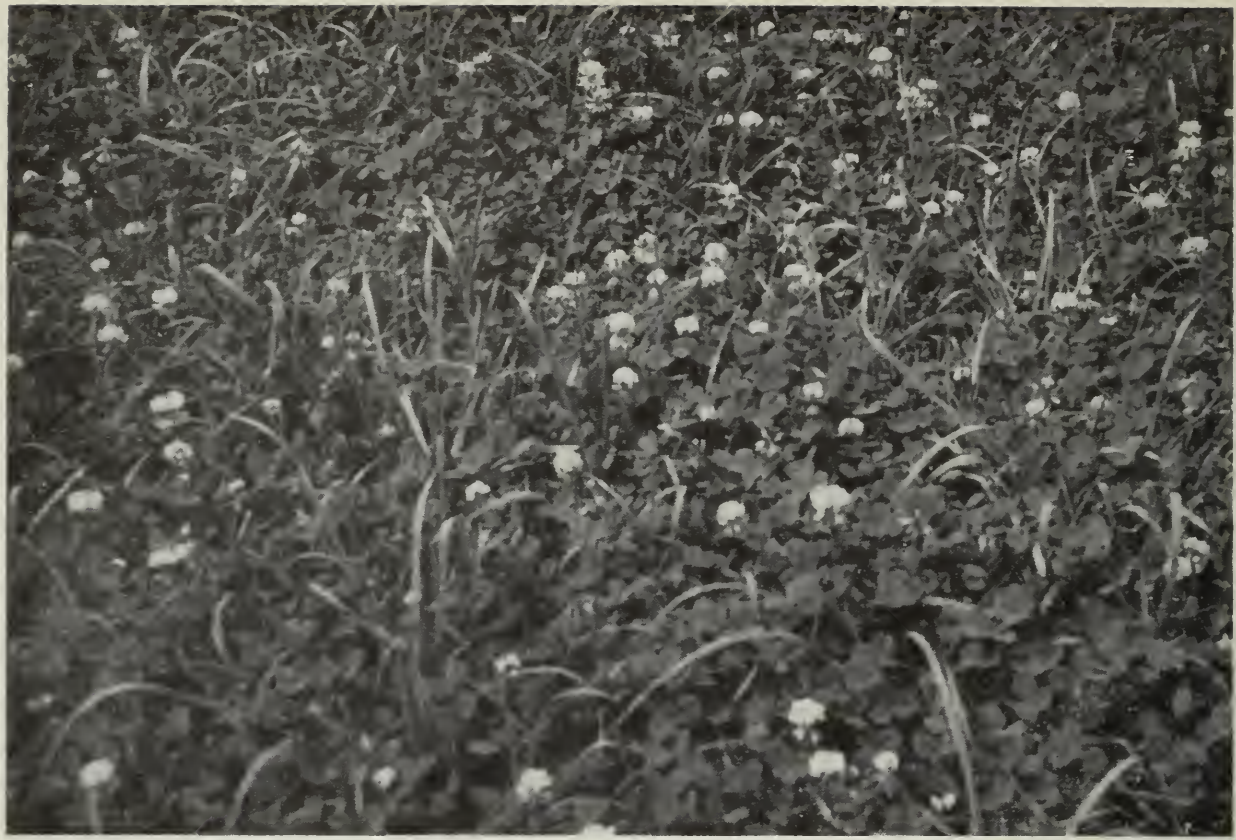


FIG. 3. This mixture of clovers and grasses protects the soil against erosion, provides excellent hay or pasture, improves the soil.

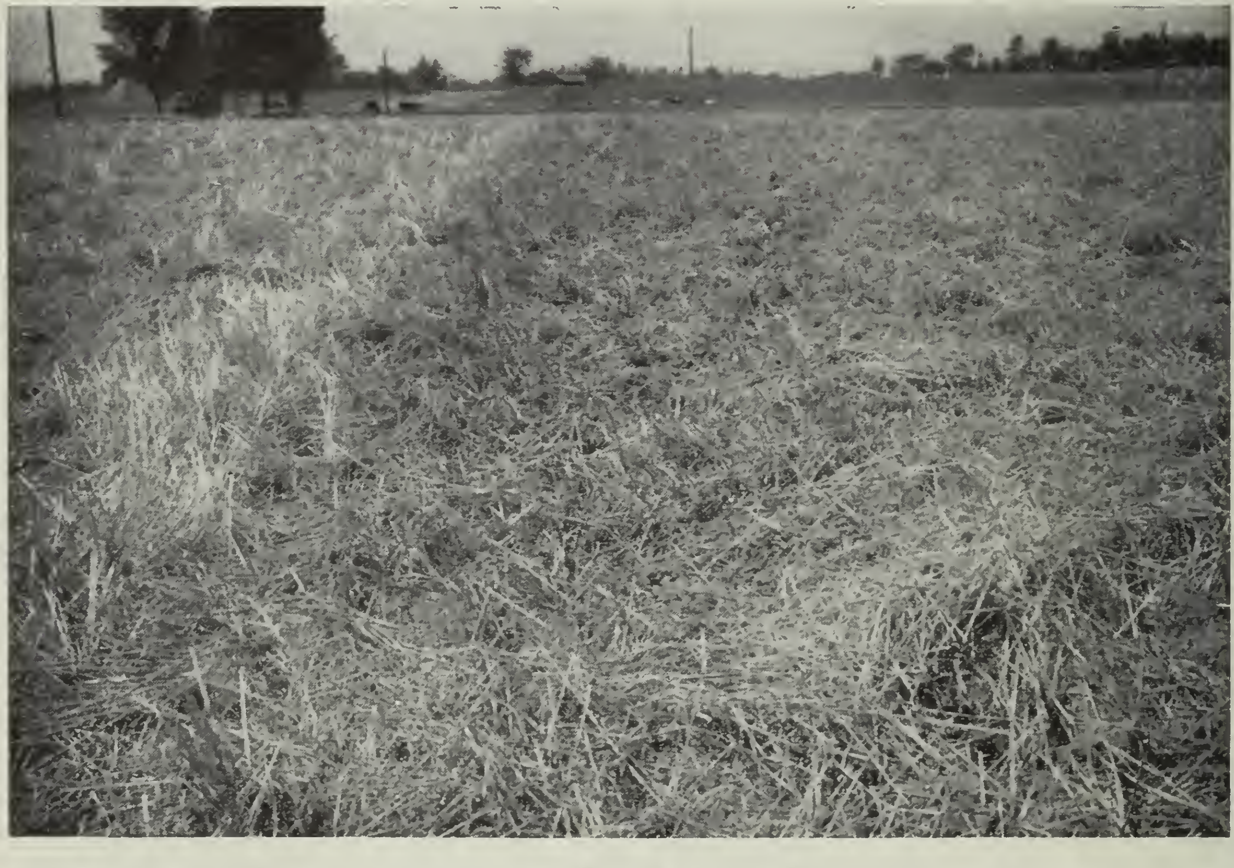


FIG. 4. Crop residues to be turned under. If straw, corn stalks or other non-leguminous crop residues are turned under, a nitrogenous fertilizer should be broadcast on top of the hay or straw before disking or plowing.

Sources of Organic Matter

Primary sources are manure (see page 11), and green-manure crops (see page 57) both legume and non-legume. These sources of organic matter you may often supplement to advantage with various other materials. In general farming the practice of leaving cereal straws on the field is increasing. Other crop residues such as roots and weeds also add organic matter. In many sections, fruit and vegetable growers find it difficult to obtain the large amounts of manure necessary for their type of farming, and they must make use of substitutes such as old hay and straw, and crop residues.

Treatment of Dry Organic-matter Supplements

When you use non-legume hay or straw, add to each ton of this material 75 pounds of ammonium nitrate, or equivalent amounts of other nitrogen carriers. This is to feed the organisms which are rotting down the dry organic matter. Broadcast the fertilizer on top of the hay or straw before disking or plowing. Six tons of dry hay or straw per acre should be the maximum application at any one time. More than this you will find difficult to handle. (Six tons of either hay or straw will add as much organic matter to the soil as twenty tons of average manure.)

Alfalfa and clover, hay or straw, are preferred dry organic-matter supplements as they contain sufficient nitrogen to bring about quick decomposition, with some slight surplus of nitrogen for crop growth. It is most desirable to *trash-disk all organic supplements* including green-manure crops, crop residues, and manures, to partly incorporate the material in the topsoil, before you completely bury it by plowing or heavy disking.

Depletion of Organic Matter

Cultivation hastens the destruction of organic matter. Nevertheless, for most crops some cultivation is essential. It destroys weeds, increases the soil's air supply, increases soil-organism activity, releases plant nutrients. However, you should keep cultivation at the minimum consistent with satisfactory yields, in order to slow down the rate of organic-matter destruction.

The amount of organic matter normal to a soil, and its rate of loss, vary with the coarseness of the soil. The more air a soil possesses, the more rapid the decomposition of organic matter. Particles making up a sandy soil are large in size with consequent big pore spaces between them, and thus more air space. Clay soil particles are very small in size, and it follows that their pore spaces are small.

Well-drained sandy soils are lower in organic matter than clay soils of similar good drainage, because there is more air present for rapid decomposition. Fresh organic material added to a sandy soil soon decomposes, reaching a low organic-matter level. The same fresh organic material applied to a clay soil will also decompose until the balance for this soil is reached, but the decomposition rate will be slower. In general it is not economically possible to maintain as much organic matter in a sandy soil as in a clay.

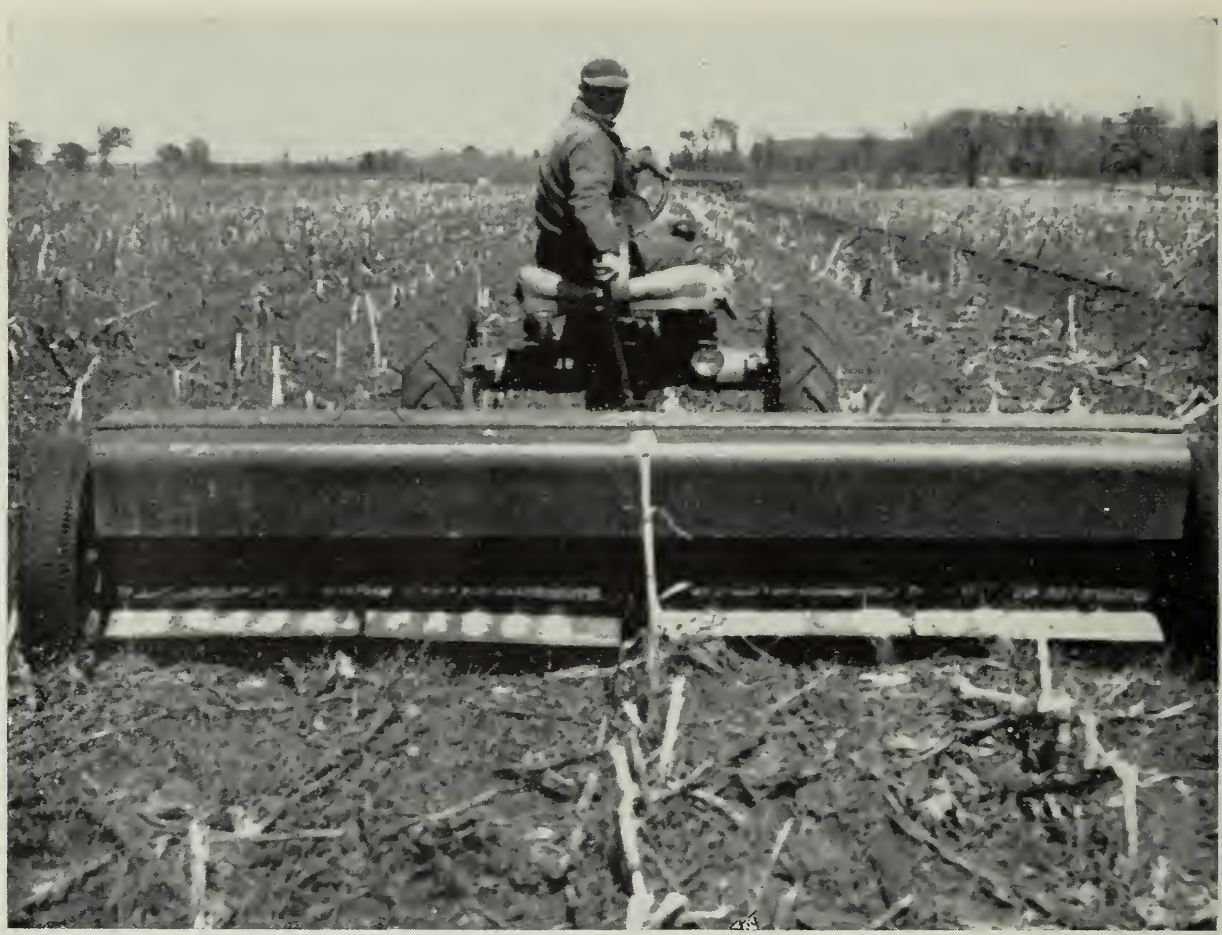


FIG. 5. Ammonium nitrate is being spread on corn stover, before incorporating the stover in the soil.

LEGUMES

For centuries we have valued the legumes as feed for man and beast. More recently we recognize their value as soil improvers. Well-known members of this family are alfalfa, clover, and soybeans. The soybean however, is a soil-improving crop only when sown broadcast and the whole plant plowed down as a green manure.

Legumes are your cheapest source of nitrogen. They are able to take it from the air and store it in root nodules; or, with the aid of bacteria, use it for plant growth. In addition, many legumes are deep-rooted, penetrating and aerating subsoil areas which might otherwise become compact and impervious to either air or water.

Legumes are among our most useful plants as a source of organic matter. Good crops of alfalfa or sweet clover may provide 3 to 4 tons (air-dry weight) per acre of good protein roughage for livestock, and still leave a ton or more of stems and roots, containing 100 to 150 pounds of nitrogen. For cover crops and for green-manuring purposes, the legumes have few equals; and fortunately most of our Ontario soils are well suited for legume production.

Valuable as they are for soil-building purposes, we must remember that legumes are heavy feeders, and to grow them well the levels of lime, phosphate and potash should be high.

FIG. 6. Ladino clover is an excellent soil conditioner. It adds organic matter, improves tilth, gathers nitrogen from the air.

MANURES

Plant-food Value

Manure annually produced on Ontario farms contains many millions of dollars worth of nitrogen, phosphate and potash. One ton of *fresh* dairy manure contains about 10 pounds of nitrogen (N), 5 pounds of phosphate (P_2O_5), and 10 pounds of potash (K_2O). Minor elements such as boron, magnesium, copper and zinc are present in most manure in a form available to plants.

Care of Manure

The natural and cheapest way for you to return to the soil as much as possible of the fertility removed by your crops is to put farm manure back on the land. Some loss of plant food, mostly nitrogen, is inevitable in the handling of manure, but if you use proper care you can hold this loss to a minimum.

With careless handling, losses of plant nutrients from manure may exceed those you sell off the farm as grain, milk, and meat. This is because most of the plant nutrients in manure are soluble, and much of it (50 per cent of the nitrogen, and 85 per cent of the potash) is already in solution in the liquid portion. About 97 per cent of the potash, 50 per cent of the nitrogen, and 50 per cent of the phosphate in manure as a whole, is soluble and can be lost readily.

There are losses of plant food from manure by leakage of the liquids through loose stable floors; soaking into barnyards and feedlots; leaching when improperly piled in the open; failure to use sufficient bedding; fermentation; and winter runoff after spreading on frozen ground. Probably only a quarter to a third of the possible plant-food value of manure is now realized.

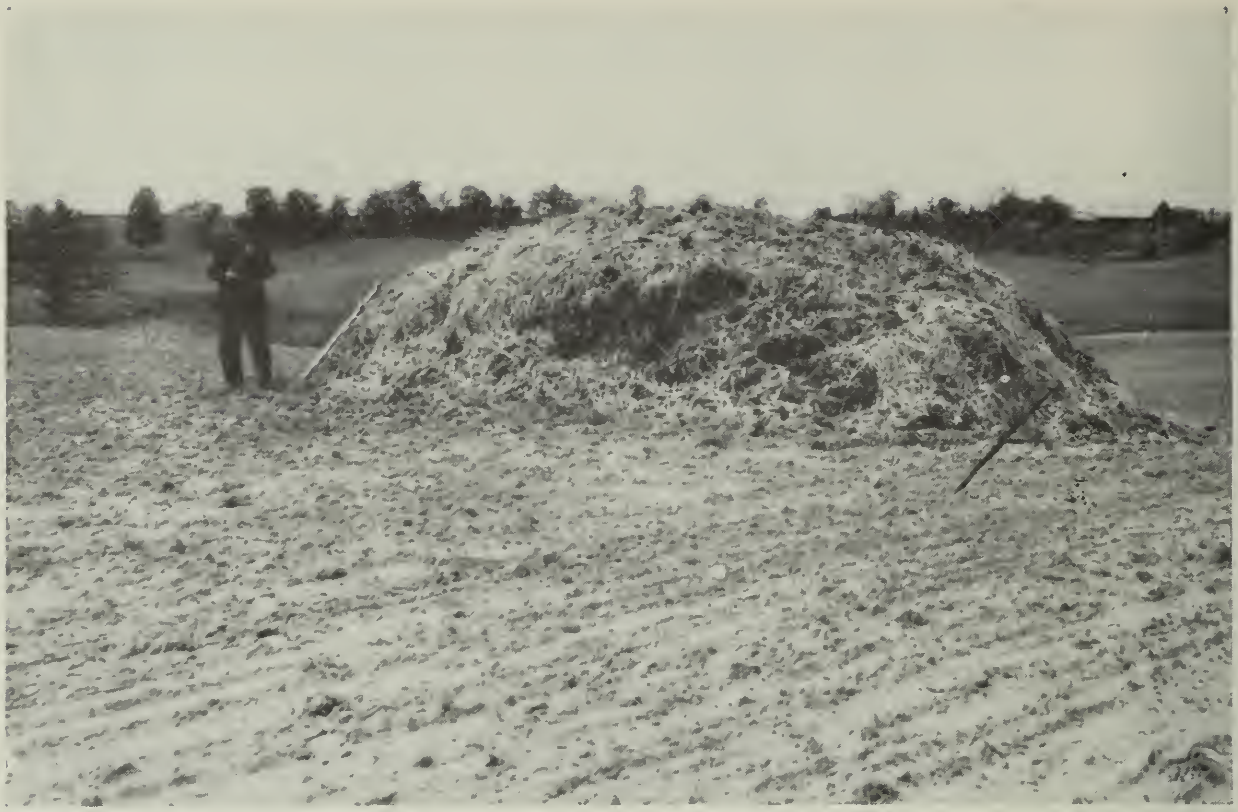


FIG. 7. Loosely piled manure is leached by rain. When manure cannot be spread immediately and must be stored outside, it should be packed tightly in large, straight-sided piles.

Adequate use of bedding or litter not only provides a clean, comfortable place for your animals, but also absorbs the valuable liquid and reduces losses from seepage and drainage. Cereal straws are the usual bedding material but unless chopped, they lack a high absorptive capacity. Wood shavings and sawdust are satisfactory. Although not in general use, peat moss is one of the best materials because of its high absorptive power. It will absorb 10 times its weight in liquids, compared to cereal straws which hold only 2 to 3 times their weight in liquids.

The sooner you spread manure and work it into your soil the higher its value and the less chance there is for loss. If it is not to be plowed under or mixed with the soil immediately after spreading, manure is better left in a manure shed or in a thoroughly compacted, moist, well-constructed pile. Manure sheds, and covered pits with concrete floors and walls, are recommended for storage. Similar pits without a cover are satisfactory provided that sufficient compaction and moisture are maintained.

If you do not have a shed or pit you can store manure satisfactorily in an open pile. Such a pile should have a relatively small base, straight sides, considerable height, proper compaction, and a location where it will receive neither roof nor surface water. Rainfall will help to keep the pile properly moist. The manure at the top will be leached but the nutrients will be retained in the bottom portion.

Where your dairy or feeder cattle are kept inside, the deep-stall method of storage is satisfactory provided there is a cement floor to prevent seepage losses. As soon as the animals are removed, remove and spread the manure, and, if possible, work it into the soil immediately. Usually such manure should be supplemented with commercial fertilizer to give a balanced supply of plant food.

Phosphated Manures

The use of superphosphate in stables is recommended. Superphosphate serves a two-fold purpose — it reinforces the manure (naturally low in phosphate) and it absorbs the easily lost gaseous ammonia (and therefore nitrogen) from the liquid manure. The calcium sulphate in the superphosphate unites with the basic ammonia in the liquid to form a stable ammonium sulphate. However, this ammonium sulphate is quite soluble and will leach out of poorly stored manure.

In the dairy barn spread 1 or 2 pounds of phosphate per cow in the gutter behind each animal each day after cleaning. In the horse stable make the application just before cleaning the stable. Ground limestone does not absorb ammonia and therefore you cannot use it as a substitute for phosphate.

Paunch and Poultry Manures

Paunch manures are partly digested crude fibre and gastric juices. They are quite acid and you must use them with caution, particularly for vegetable growing. When used, you should add lime to counteract the acidity. Add nitrogen too, to stimulate bacterial action in breaking down the crude fibre; otherwise your crop may lack sufficient nitrogen.

Poultry manure is much higher in nitrogen and phosphate than ordinary farm manure, and somewhat lower in potash (see Table 1, page 20). Therefore it needs less additional fertilizer to make it a balanced plant food.

Because of its very high nitrogen content poultry manure must be used with caution, especially in orchards and berry plantations. An application of 3 tons of litter — manure and straw — per acre should be the maximum at any one time. Droppings without the litter should be applied with exreme caution, and certainly at reduced rates.

Application Rates for Manure

In general farming frequent, light to medium applications of manure, give greater returns per unit than heavy, infrequent applications. On the other hand, for orchards and berry plantations, and particularly for vegetable crops, apply manure in fairly heavy amounts. Here, the more intensive cultivation and cropping practices deplete the organic matter at an increased rate, requiring heavier and more frequent use of manure (or supplements).

If the supply of manure is limited, you would do better to put what you have on a small area, than to apply a small amount to a large area. In fruit for instance, 20 tons of manure might better be applied to one acre rather than spread this amount over two acres. The following year the second acre can be manured.

"Man's living is derived from the soil alone, and as long as people and soil survive, the real sources of civilization survive."

Elmer T. Peterson of the Daily Oklahoman.

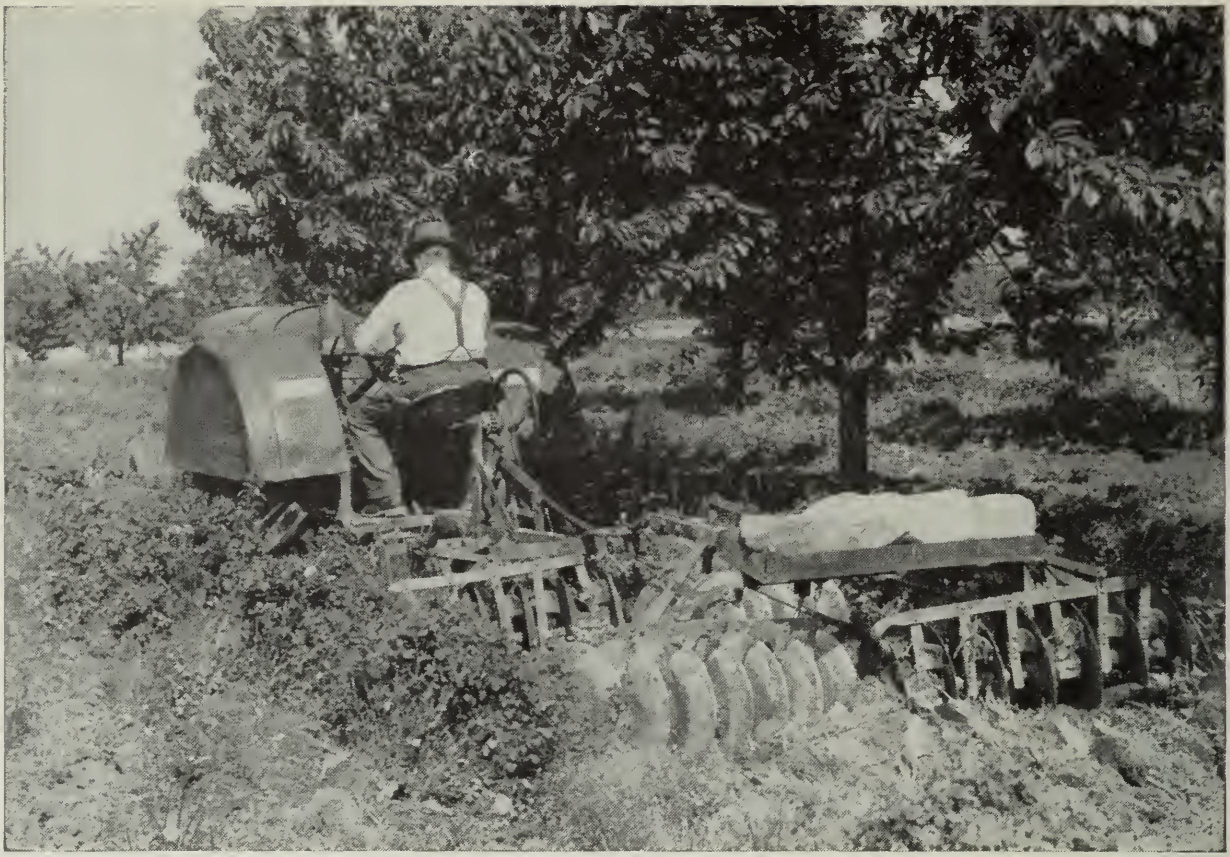


FIG. 8. First trash disk green-manure crops and plant residues to partly incorporate them in the topsoil. Then plow under.

SOIL MICRO-ORGANISMS

Soil is alive, truly and literally. The extent to which it is alive — with micro-organisms — is one measure of its productivity. A "lifeless" soil, however well supplied with plant-food elements and *dead* organic matter, can never be normally productive. Therefore we must concern ourselves with this microscopic life and the part it plays in providing food for our crops.

All living things supported by the soil — crops, crop remains, green manures, old hay and straw and other dry organic matters — return in the end to the soil. There they are broken down, rotted, by swarms of living microscopic organisms. In the top foot of an acre of fertile soil there are from 2 to 3 *tons* of these organisms.

Most of these organisms help in crop production, although some are harmful. However, the helpful ones, if you give them a chance, will keep the upper hand. That means keeping the soil in good physical condition, well aerated, and well supplied with fresh organic matter, the food supply of the micro-organisms.

So it is important for us to see that these organisms (call them what you like — micro-organisms, soil organisms, micro-biological life) are well fed, well cared for. If we do that, they will release plant food for crop use. For it is true that most of the food which our farm crops use must first be worked on, and released, by micro-organisms. Almost, we may say that, if we feed the micro-biological life of the soil, it, in turn, will feed our crops.

In the process of feeding themselves micro-organisms rot down fresh organic matter. In turn, they themselves die, by uncounted billions, to add to soil organic matter and its eventual humus content. In this organic matter there are carbohydrates, proteins, fats, waxes, and cellulose materials. The micro-organisms decompose these, some more rapidly than others, to form humus, a rather uniform, dark-colored material. This humus is further broken down, although more slowly, into end products, principally water, carbon dioxide, ammonia, methane, and small amounts of free nitrogen and mineral salts.

Bacteria and fungi are the main groups of micro-organisms in organic-matter decomposition. Bacteria are the smallest, most numerous, and most important. Some bacteria change the ammonia to nitrites and finally nitrates, the needed form of nitrogen for most plants. Other bacteria inhabit the nodules which develop on the roots of legumes from which they get food; and in return, they fix nitrogen from the air and help replenish the supply in your soil. If your soils are slightly acid to slightly alkaline in reaction, and well supplied with good-quality organic matter, the content of beneficial bacteria is likely to be high.

The fungi are most numerous and active under soil conditions more acid than bacteria will tolerate. They are not as efficient as bacteria in decomposing organic matter, nor have they the ability to change ammonia and nitrites into nitrates.

CULTIVATION

Trash Cultivation

You may wish to plow-under moderately large amounts of such organic materials as crop residues, green-manures, weed growth, or old hay or straw. If so, first mix this material with the topsoil by light disking. This is trash cultivation, and it avoids a solid "mat" of undecomposed organic material between the plow layer and the soil below. Then if your soil is fertile, and not too acid, earthworms will further assist in mixing the organic material with the mineral soil.

Cultivation Generally

The main purposes of cultivation or tillage are, (a) to prepare a seedbed; (b) to kill weeds; and (c) to work crop residues or cover crops into the soil. In some cases all three purposes can be accomplished in one operation.

In preparing a seedbed there are usually two stages, the deeper or basic tillage, and, later, the surface working and compacting tillage. For most crops it is important that you prepare a firm but well-aerated seedbed. This is more easily done in the lighter, coarse-textured soils, and in soils well supplied with humus.

Cultivation to kill weeds is usually done in three places in a rotation: in the row crops; in the summer in preparation of the soil for sowing fall grain; and after grain crops are harvested. Keep in mind that each time you stir the soil air circulates more freely and organic matter decomposes more rapidly. That is, cultivation speeds the decay of organic matter — a "stoking the furnace" process to be recognized as such. The heavier the stoking to release plant food and promote crop growth, the more "fuel" or organic matter must be added.

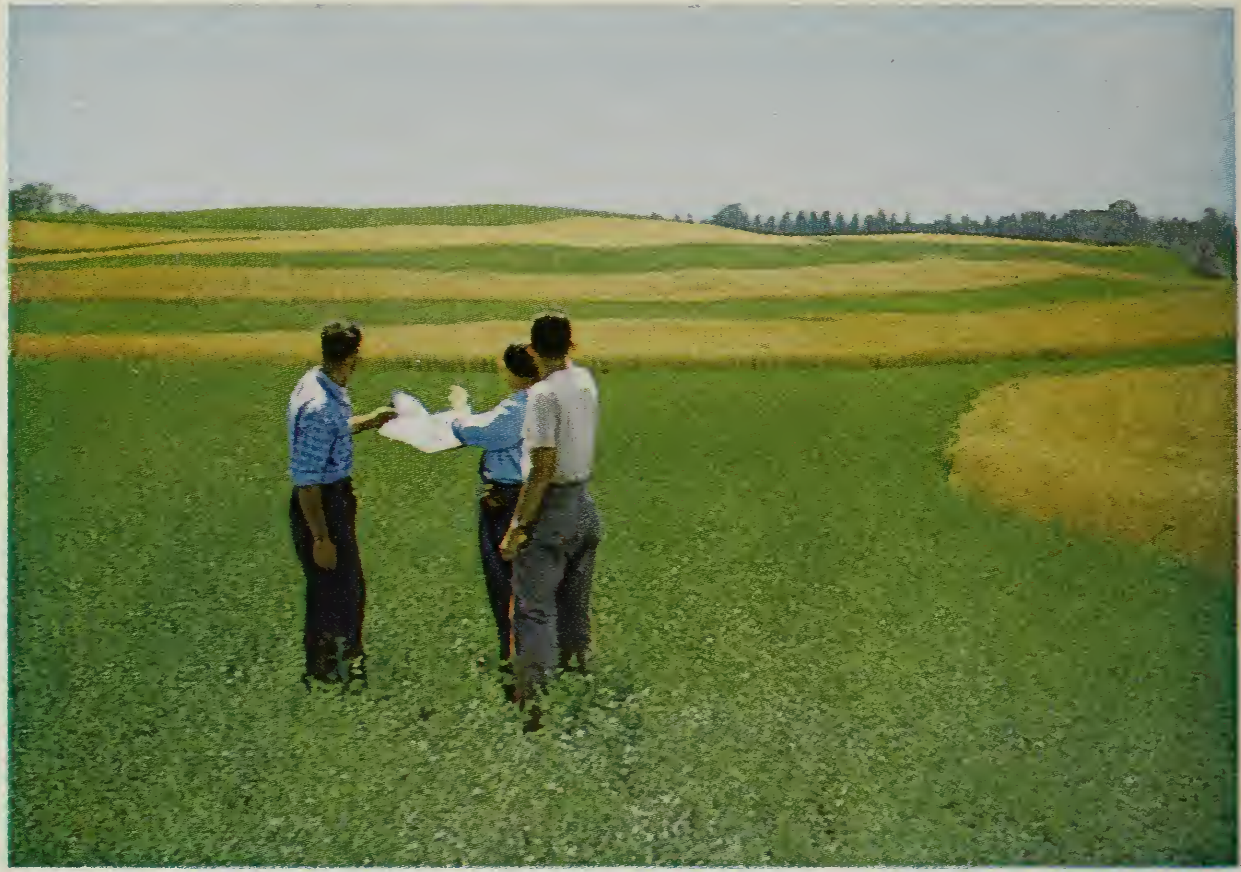


FIG. 9. Contour farming protects the fertile topsoil from sheet erosion, conserves plant food.

On sloping land it is best to cultivate and plant the crops across, rather than up and down the slope. In many irregularly sloping fields this may not be practical. Where it is possible it assists rainfall to soak in where it falls and is needed by crops; otherwise it runs rapidly down the slopes often taking much good topsoil with it.

Frequent cultivation may so deplete organic matter that the soil's water-holding capacity is lowered. This is just as important for the cereal crops as it is for the more intensive fruit, vegetable, and hoed crops. We once thought that cultivation conserved moisture. Actually it conserves moisture only in-so-far as it removes competing weeds or cover crops. In fact frequent and deep stirring of soil may speed up water losses by exposing fresh amounts of moist soil. Also, loss of soil structure from over-cultivation may be worse than moderate weed competition.

Reduce cultivation to a minimum for the soil type, the crop, and the conditions. If one or two cultivations serve your purpose then more are a needless expense, and only increase the loss of organic matter, impair soil structure, and lower soil moisture.

Depth of cultivation is important. The deeper you cultivate, the more active the destruction of organic matter, and the faster soil structure is destroyed. Also, you may injure shallow-rooted crops by cutting feeding roots.

In short, while tillage is needed for many crops, we must recognize that, the more soil is cultivated, the greater its loss of structure, the less fertile it becomes, the more tillage it requires to maintain production, and the less effective tillage becomes. It can be a vicious circle.

THE INHERENT FERTILITY OF SOILS

The soils of Ontario are widely different, varying from sand to clay, from over-drained slopes to water-logged bogs, and from level plains to rugged hills. In weaving a piece of fabric, as the proportion of wool and cotton is varied, the composition and make-up of the finished product differs. So too, the supply of plant nutrients in soils varies with differences in rock materials from which the soils were formed. For example, soils formed from dominantly limestone bedrock will differ greatly from those formed from granitic rocks.

The ability of a soil to provide plant nutrients for crop growth is closely related to soil texture. Generally speaking, the coarser-textured soils (sands and sandy loams), are less well-supplied with, and lose plant nutrients more quickly, than the finer-textured soils (loams, silt loams, clay loams, clays). Nutrients become readily available for plant use in soils with good structure and well supplied with organic matter. It is under such conditions that the greatest activity of the soil micro-organisms, and the most rapid mineral breakdown, take place.

Ontario Bulletin 492, Ontario Soils, their Use, Management and Improvement, contains much useful information (pages 16 to 18) on what happens to nitrogen, phosphorus, and potassium in varying soils; and the role of each element in plant growth.

Even though you manage your soils well, they will not likely supply all the plant food your crops could use. Fertilizers may well be needed in some amount. But fertilizers are not a substitute for good farming. If you use them as such they will result in a more rapid loss of soil structure and organic matter. These losses will slow-down the natural plant-food-producing activities in the soil body itself. Then, still more fertilizer, in an effort to keep up your crop production, will likely make matters worse.

Fertilizers can be, and should be, a very profitable supplement to good soil management. The profit will increase as good soil management improves the structure and organic content of the soil.

LOSSES OF PLANT FOOD FROM THE SOIL

Losses of nutrient elements from a soil cannot be completely stopped; they can be lessened only. Losses may result from fixation, leaching, erosion; and sale of crops, animals, and animal products.

Fixation

In many soils there is a chemical "hunger" for one or more mineral nutrient elements such as phosphorus and potassium. To satisfy this hunger these elements, when applied as fertilizers, may become what we loosely call "fixed", and therefore not available for plant use.

However, this fixation does not ordinarily represent a permanent loss. Usually it is temporary only, and elements so fixed again become available, slowly, over a period of years. This may be a disadvantage to the immediate needs of a crop, particularly if you are too sparing in your use of fertilizers.

Fixation is Nature's way of conserving plant food. If it were not for fixation, a great deal of the natural fertility of our soils, as well as applied fertilizers, would be leached out by rainfall, or cropped off. Fixation occurs more quickly and is more serious in fine-textured clay soils than in the coarser, sandy soils.

Phosphorus is probably the most rapidly fixed of the major nutrient elements, with potassium second. In acid soils, fixed phosphorus is least available to plants. In alkaline soils, the fixed phosphorus is more available to lime-loving plants like alfalfa, sweet clover and other legumes, than to non-legumes with a low calcium requirement such as the grasses. A neutral to slightly acid soil offers the best medium for phosphorus availability. This does not mean that phosphorus will not be fixed under such conditions, but it does mean that phosphorus, even when fixed, will become relatively easily available to the roots of most crops.

With potassium, what we call fixation is not really the same as fixation with phosphorus, although we shall continue to use that term for both. Potassium fixation is a more temporary tie-up than is the case with phosphorus. On some soils, especially acid soils, a considerable part of the applied phosphorus may become so fixed as to be permanently unavailable to plants.

When potassium is fixed in the soil a good proportion of it acts as a reserve to be eventually released in available form. It is, therefore, not entirely lost. This year's crop removes from the soil some non-fixed or available potassium which is restocked in part at least, from the fixed reserve, for next year's crop. Such a system helps to maintain a soil at a constant level of available potassium. Low levels of available potassium may be gradually increased by continued use of potash fertilizers.

Potassium fixation may occur in all soils to some degree but its extent is usually not important in sandy soils. Wetting and drying of soils, or freezing, aid in potassium fixation. Soils which have a high lime content may fix potassium even if they are kept continuously moist.

On alkaline soils, available potassium is likely to be low to medium only, due to rapid fixation. Therefore, above-normal amounts of potash should be applied to provide a surplus after fixation for crop seeds.

In general, fixation of all elements can be reduced by plowing or disking-in manure, crop refuse and residues, or green crops; use of lime on acid soils; drilling rather than broadcasting fertilizers; use of granular forms of fertilizers; deep placement of fertilizers; preventing the erosion of the topsoil.

Leaching

Losses of plant nutrients by leaching vary with differences in soil and soil management, and with changeable weather conditions. The most-leached soils are usually the well-drained coarse-textured sands and sandy loams. Since organic matter acts as a storehouse of soil fertility, you can reduce leaching losses by maintaining organic matter in good supply.

Erosion

The subject of erosion is dealt with in comprehensive detail in Ontario Bulletin 492, Ontario Soils, their Use, Management and Improvement. (Pages 19 to 38).

The most fertile part of a soil is the topsoil, and this is the part which goes first in the process of erosion. In gully erosion. the coarse subsoil and underlying material often is spread out over good soils at the bottom of the slope, and the finer silt and clay are carried away in the rivulet, creek and river, and finally deposited in the lake.

This gully erosion is spectacular, but a much greater total loss of plant food results from sheet erosion. Whenever soils are bare and unprotected the heavy dashing rains gnaw at even the most gentle slopes, and the surface run-off carries with it some of the finer topsoil. The greater the speed of the water run-off, the greater the amount of soil carried.

Erosion preventive measures are: (a) Leave the soil bare as little as possible, and still be in keeping with good farm practice. (b) Maintain a good supply of humus by returning crop residues, manures, etc.; and by growing clovers, grasses and cover crops. This will help to keep your soil more porous, and permit rain to soak in. (c) Cultivate across the slope where practicable. (d) On slopes that erode easily leave sod strips between cultivated strips. (e) Leave the waterways in sod. (f) Cultivate only the more level land and leave the steeper slopes in permanent pasture or bush.

Removal by crops

If your soil is well managed, Nature will supply a large part of the plant food required for satisfactory crop production. However, run-down soils, low-fertility soils, and even most of our so-called good soils, usually require additions of one or more nutrients for good yields of high-quality crops. Also, analyses of crops show that the amounts of the different nutrients taken by crops vary widely with seasons, and with soils.

Let us look at the magnitude of these losses in terms of fertilizer replacements on an average farm. A good dairy cow will produce 8,000 pounds of milk in one year. Into that she will put phosphorus equal to that contained in 100 pounds of ordinary 20 per cent superphosphate. With a herd of twenty such cows, and the milk all sold off the farm, the annual loss of phosphorus from the farm, by this means, would be equivalent to one ton of 20 per cent superphosphate.

Or, if you prefer, let us consider the sale of livestock from the farm. One thousand pounds of livestock carries the average phosphorus equivalent of 80 pounds of 20 per cent superphosphate. If you sell 2 or 3 head of cattle, also calves, hogs, poultry and poultry products, these take with them fertility elements from the soil.

So, also, if you sell grain. Every 40 bushels of wheat, or every 50 bushels of barley sold take from your farm the equivalent of 100 pounds of superphosphate. It is these continued losses which eventually deplete your soil minerals, unless the losses are made up from the soil's natural mineral content, or by use of fertilizers, or both.

Table 1 lists a number of crops showing the loss of nutrient elements at given crop yields. Remember of course, that legumes make use of nitrogen from the air; also that plant composition may vary with varying soil fertility. For instance, a corn yield of 75 bushels is possible with a certain nitrogen and moisture level, and where phosphate and potash are not limiting. If you add more phosphate and potash to your soil yields may not increase, because nitrogen or moisture may now be limiting, but the percentage of phosphorus and potassium *in the plant* may increase. Such cases give rise to variable plant composition. The figures in the table are good averages under ordinary field conditions, but any particular field may give plants of mineral composition higher or lower than those listed.

TABLE 1. NUTRIENTS CONTAINED IN FARM CROPS AND PRODUCTS*

Crop	Yield	Part of Crop	Pounds		
			Nitrogen (N)	Phosphate (P_2O_5)	Potash (K_2O)
Barley	50 bu.	grain	43.6	18.7	12.5
	2,500 lb.	straw	18.7	6.2	37.5
			62.3	24.9	50.0
Beans	25 bu.	seed	60.0	18.0	19.5
	2,000 lb.	straw	28.0	6.0	38.0
			88.0	24.0	57.5
Buckwheat	20 bu.	grain	15.0	6.0	3.0
	5,000 lb.	straw	62.5	7.5	57.5
			77.5	13.5	60.5
Corn	75 bu.	grain	71.2	28.7	18.7
	4,500 lb.	stover	47.5	15.0	68.7
	750 lb.	cobs	3.0	0.6	3.3
			121.7	44.3	90.7
Flax	15 bu.	grain	30.5	12.5	8.2
	1,800 lb.	straw	20.5	3.4	18.8
			51.0	15.9	27.0
Oats	75 bu.	grain	52.5	22.5	15.0
	3,750 lb.	straw	22.5	7.5	52.5
			75.0	30.0	67.5
Peas canning	1,800 lb.	grain	66.0	15.4	18.0
	4,500 lb.	straw	45.0	8.5	47.7
			111.0	23.9	65.7
Rye	30 bu.	grain	28.6	14.7	10.0
	3,000 lb.	straw	15.0	9.0	25.5
			43.6	23,7	35.5
Soybeans	25 bu.	grain	110.0	35.0	40.0
	2,500 lb.	straw	15.0	5.0	20.0
			125.0	40.0	60.0
Tobacco	1,500 lb.	leaves	55.0	10.0	80.0
	1,500 lb.	stalks	25.0	10.0	35.0
			80.0	20.0	115.0
Wheat	40 bu.	grain	46.6	21.3	12.0
	3,330 lb.	straw	20.0	5.3	28.0
			66.6	26.6	40.0
Mangels	20 ton	roots	60.0	40.0	140.0
Potatoes	300 bu.	tubers	65.0	25.0	115.0
		tops	60.0	10.0	55.0
			125.0	35.0	170.0

Table 1. Nutrients Contained in Farm Crops and Products* *(contin'd)*

Crop	Yield	Part of Crop	Pounds		
			Nitrogen (N)	Phosphate (P_2O_5)	Potash (K_2O)
Sugar beets	15 ton	roots	55.0	22.0	53.0
		tops	60.0	23.0	92.0
			115.0	45.0	145.0
Turnips	10 ton	roots	50.0	20.0	90.0
Alfalfa hay	3 ton	all	140.0	30.0	135.0
Bluegrass hay	2 ton	all	53.0	21.6	84.0
Millet hay	3 ton	all	75.0	27.0	90.0
Red clover hay	2 ton	all	80.0	20.0	70.0
Soybean hay	2 ton	all	92.0	28.0	44.0
Sweet clover hay	5 ton	all	185.0	45.0	165.0
Timothy hay	1.5 ton	all	40.0	15.0	45.0
Apples	400 bu.	fruit	20.0	7.0	30.0
		leaves, wood	10.0	3.0	5.0
			30.0	10.0	35.0
Blackberries	4,000 qt.	fruit	11.0	3.0	12.0
Cherries	8,000 lb.	fruit	16.0	4.0	20.0
Grapes	4 ton	fruit	10.0	6.0	20.0
		leaves, canes	15.0	4.0	15.0
			25.0	10.0	35.0
Peaches	500 bu.	fruit	30.0	15.0	55.0
		leaves, wood	55.0	10.0	45.0
			85.0	25.0	100.0
Pears	300 bu.	fruit	7.5	3.0	15.0
Plums	200 bu.	fruit	15.3	5.5	21.3
Raspberries	4,000 qt.	fruit	10.5	4.5	12.0
Strawberries	6,000 qt.	fruit	13.5	10.3	27.0
Beets	12.5 ton	roots	62.5	25.0	125.0
Cabbage	15 ton	all	100.0	25.0	100.0
Carrots	10 ton	roots	46.0	26.0	106.0
Cauliflower	7.5 ton	heads	42.0	15.0	50.0
Celery	350 crates	tops	80.0	65.0	235.0
Cucumbers	100 bu.	fruits	5.5	3.3	11.0
Onions	500 bu.	bulbs	65.5	25.5	62.5
Parsnips	6 ton	roots	26.4	24.0	78.0
Tomatoes	10 ton	fruit	60.0	20.0	80.0
		vines	40.0	15.0	95.0
			100.0	35.0	175.0
Spinach	9 ton	all	90.0	30.0	45.0
Sweet corn	2 ton	ears	18.0	8.0	12.0
Cow manure	1 ton	86% moisture	9.7	2.8	9.5
Horse manure	1 ton	78% moisture	14.2	4.8	12.4
Poultry manure	1 ton	55% moisture	20.0	16.0	8.0
Sheep manure	1 ton	68% moisture	20.6	7.0	19.8
Swine manure	1 ton	87% moisture	7.6	6.8	8.4

* Compiled, amended, and re-arranged from "Fundamentals of Soil Science by Millar and Turk", and, "When Fertilizing Consider Plant-food Content of Crops", by Romaine.

SOIL REACTION, OR pH OF SOILS

Soil reaction is a term we use when talking of the acidity or alkalinity of a soil. We speak of the pH of a soil when we measure its degree of acidity or alkalinity; and we express that degree of reaction in a pH scale varying from 0 to 14. Neutral is 7.0.

For most Ontario soils pH values fall between 4.5 and 8.5. The best soil reaction for most agricultural crops lies between pH 6.5 and 7.0. Table 2 is simply a word rating for various pH values.

TABLE 2. A pH SCALE OF SOIL REACTION

pH Value	Rating (in plant terms)
Below 5.5	Strongly acid
5.5 - 5.9	Moderately acid
6.0 - 6.4	Slightly acid
6.5 - 6.9	Very slightly acid
7.0	Neutral
7.1 - 7.4	Very slightly alkaline
7.5 - 8.5	Slightly to moderately alkaline

Chemically, soil pH values do not indicate strong acid or alkaline reactions, but rather varying degrees of mildness. However, to a plant, a pH below 5.5 or above 8.5 may be severe, and so we use the terms "strongly acid", "moderately alkaline", etc.

The pH scale is used for other things besides soil. For example the pH value of lemon juice is from 2.2 to 2.6; orange juice 3.4 to 4.0; sour milk (curdling) 4.6 to 4.8; fresh milk 6.6 to 6.9; and pure water 7.0, or neutral.

TABLE 3. FAVORABLE pH RANGES FOR SOME CROPS

FIELD CROPS		FRUIT CROPS	
Alfalfa	6.2 - 7.8	Apple	5.0 - 6.5
Barley	6.5 - 7.8	Blueberry	4.0 - 5.0
Clover	6.0 - 7.5	Cherry	6.0 - 7.0
Field Bean	6.0 - 7.5	Grape	5.5 - 7.0
Field Pea	6.0 - 7.5	Peach	6.0 - 7.5
Oats	5.0 - 7.5	Pear	6.0 - 7.5
Rye	5.0 - 7.0	Plum	6.0 - 8.0
Soybean	6.0 - 7.0	Raspberry	5.0 - 7.0
Wheat	5.5 - 7.5	Strawberry	5.0 - 6.5
HOED CROPS		VEGETABLE CROPS	
Bean	6.0 - 7.5	Cabbage	6.0 - 7.5
Corn	6.0 - 7.5	Carrot	5.5 - 7.0
Mangel	6.0 - 7.0	Cauliflower	5.5 - 7.5
Potato	4.8 - 6.5	Celery	5.8 - 7.0
Pumpkin	5.5 - 7.5	Cucumber	5.5 - 7.0
Sugar Beet	6.5 - 8.0	Lettuce	6.0 - 7.0
Tobacco	5.5 - 7.5	Onion	5.8 - 7.0
Tomato	5.5 - 7.5	Pea	6.0 - 7.5
Turnip	5.5 - 6.8	Table Beet	6.0 - 7.5

THE NUTRIENT ELEMENTS

The Major Elements

Nitrogen, phosphorus and potassium are often termed the major elements. This is because plants require them in relatively large amounts, and because they are often present in insufficient quantities in our soils. Magnesium and calcium are also major elements but are not commonly known as fertilizers. Magnesium may or may not be low in acid soils, and is sometimes low in alkaline soils.

In acid soils calcium is usually in short supply. Lime, or the calcium in it, adjusts soil acidity (see Soil Reaction or pH of Soils, page 22); supplies calcium (and sometimes magnesium) as plant nutrients; and is an aid to improved soil structure. Also, the micro-organisms which take nitrogen from the air work best if your soil is approximately neutral, that is, has a pH of about 7.0. Your soil may need lime to bring about this "neutral" reaction. And if your soil is clay, it will need more lime to change its acidity than a sandy soil of equal acidity will need.

Sulphur is another element which we could call a major one. However, it is not commonly deficient in our soils, chiefly because it is added in the fertilizers supplying nitrogen, phosphorus and potassium.

The Minor or Trace Elements

The so-called minor, or trace elements, boron, copper, iron, manganese, molybdenum and zinc, are as necessary to plant growth as the major elements, but in relatively small amounts only. But they *are* necessary for normal growth, and therefore "trace" is perhaps a better word than "minor" for us to use.

The longer we till a soil, and the higher the crop production, the more we may impair the nutrient balance (page 25) of that soil. This is particularly true of trace elements.

Present fertilizers containing the major elements, nitrogen, phosphorus and potassium, usually carry some trace elements as well but in very small amounts. They are there because they were in the materials used in the manufacture of the fertilizer. This condition may change as fertilizers become more concentrated, and are made from more refined materials.

Some Ontario soils, in their natural state, may lack one or more trace elements. In general, however, until recent times, our crops have obtained trace elements in sufficient amount from the original supply in the soil, from manures, and from "unrefined" commercial fertilizers. The picture is changing due to several factors, including long-continued cultivation, increased per-acre crop production, and the use of more refined materials in fertilizer manufacture.

There are some outstanding examples in Ontario where the lack of even minute quantities of some of the trace elements has caused serious crop losses. For instance, a deficiency of boron has caused cat-scratches on celery; drought spot. water-core or heart-rot of root crops, especially turnips and sugar beets; breakdown of beets and cauliflower; drought spot or corky core of apples; dieback of apricots and prunes; reduction of seed yields of legume crops. A lack of manganese has been observed in soybeans, certain vegetable crops, and is the cause of "grey speck" or yellowing of oats; manganese is tied up with chlorophyll production. Copper is required by most organic or muck soils, particularly when onions, spinach and carrots are being grown on them.

Two other elements which are being studied in Ontario are iron and molybdenum. Iron is associated with chlorophyll production; while a lack of molybdenum, although it is required only in minute quanities, is responsible for poor plant growth.

In general, iodine and cobalt are not believed to be vitally important in plant growth. It is known, however, that certain nutritional diseases will occur with humans and livestock which are compelled to live on food produced from soils deficient in iodine and cobalt. There are areas in Ontario where one or both of these trace elements are known to be deficient. Consequently, the feeding of salt, reinforced with iodine and cobalt, is now an accepted practice.

All trace elements are present in small amounts in good soils, but poor soil management can seriously upset the over-all nutrient balance of the soil. This, in turn, is reflected in lack of production, reduced quality, or both. Overlimed or naturally limey soils may "tie up" certain trace elements in insoluble forms. They are then unavailable to your crops although otherwise there may be sufficient quantities of the elements in the soil.

Correction of trace element deficiencies is not simple. Some of the trace elements are toxic (see page 28) to certain plants, when present or when applied in too large amounts. Boron and copper additions to organic soils can be easily overdone, with serious consequences to the crop and with possible damage to later crops. Some crops respond to trace-element sprays (see Foliar Applications, page 34) in concentrations as low as one per cent.

"Preventive" use of trace elements can be both needless and dangerous (see Toxic Effects of Excess Nutrients, page 28). And our soil test methods for trace elements are not yet satisfactory. No general recommendations, therefore, can be made. When we have sufficient knowledge for a particular crop you will find the recommendation under that crop.

The most recent "view" on trace elements is that the time or growth stage at which they are available to a given crop. may determine the plant response. Much work needs to be done here, and even when some of the answers are known we may not be much better off. For it will be difficult to translate such critical timing into something useful and practical under average farm conditions. Here is what World Crops, an authoritative British publication, has to say in its May, 1953 issue.

> "Much more research had been devoted to the amount of trace elements needed by plants than to the times or stages of growth when supplies are required. A recent letter in *Nature* (1953, 171, 438-9) reports an exceedingly interesting experiment on the time-table of manganese requirements for tomato plants. Complete control over nutrient supply was obtained by using the so-called 'water-culture' method of investigation. In the first experiment plants were grown so that managanese could be supplied or withheld in four consecutive two-week periods during growth; in total eight different patterns of mananese supply were compared. It was found that an absence of manganese in the first two-week period did not adversely affect growth. Broadly, normal development from germination to early fruit formation was obtained provided that manganese was available during the middle

periods; that is, in the third to sixth weeks during the total period of eight weeks.

"In the second experiment narrower time control was set, and it was then found that no adverse effects upon development occurred if manganese was available for just one week in the third fortnight after sowing. 'The manganese absorbed during this period was sufficient for normal growth for a further four weeks.'

"These results would seem far from academic. We do not mean that growers need develop a calendar complex towards trace elements. Broadly speaking, it does not much matter when manganese is present so long as it is there at a reasonably early stage. But in other manganese research it has often been found that foliage spraying was far more effective in correcting manganese deficiencies than soil applications, and the common belief has been that the soil-applied manganese became 'locked up' by the same soil factors that had 'locked up' the natural supply of manganese. Another interpretation can now be put forward. Foliar spraying may have been more effective because it took place at or near the critical *time* of need, whereas soil applications failed to reach the plant until after that critical phase of development. In this whole question of method of application of trace elements there have been plenty of anomalous results. This time factor may be the missing factor. *When* seems as influential a condition as *how or how much.*"

Nutrient Balance

While each of the nutrients, major and minor, helps plant growth in its own way, we now believe that the "balance" between nutrients is quite important. If this balance is really out of line, and there is too much of this nutrient, or too little of that, the plant will show it. There will be "symptoms" of excesses or deficiencies. These you will find discussed elsewhere in some detail. (Hunger signs in Plants, page 27); (Toxic Effects of Excess Nutrients, page 28). Here we simply mention, as examples, that pale foliage may indicate nitrogen starvation, marginal scorching of leaves suggests potash starvation, internal breakdown of turnips is a symptom of boron need.

If, for the moment, we consider plant health only, and not crop yield, we shall find that this *balance* of nutrients is more important than the *total* of nutrients present. The plant will be healthy, (though yield may be low) if the nutrients are in balance, though at a generally low level. For plant health *plus* crop yield, you will need to step up the level of *all* major nutrients, but being careful of the balance between them. If nitrogen is low as compared with phosphate and potash, the plant cannot use these minerals to advantage. And if there is too much nitrogen your plants may show a potash deficiency.

Even if you start with a well-balanced soil, virgin or otherwise, you may throw it out of balance. You can do this by too much cultivation with its destruction of organic matter and loss of soil structure; or by repeated use of one nutrient such as potash, or phosphate; or by continued use of one complete fertilizer, whether or not it is what your crops really need. It is here that soil tests have their value.

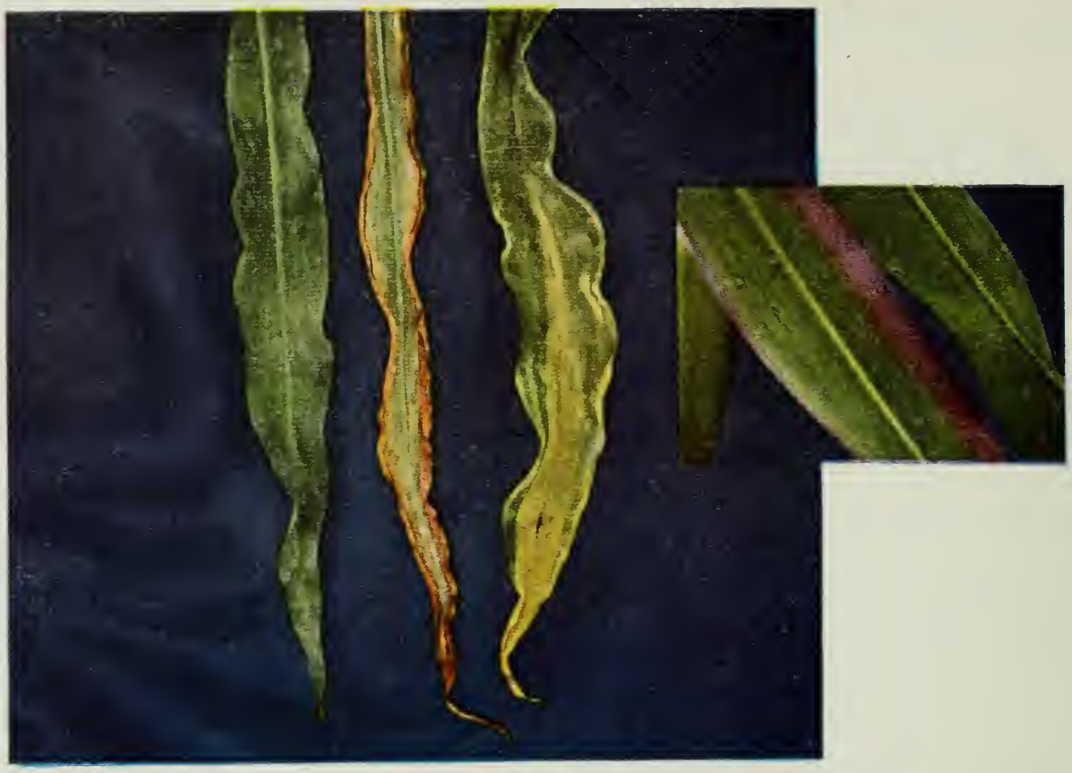


FIG. 10. Hunger signs in plants. Nitrogen-, potassium-, and phosphorus-deficient leaves. Consider first the three in a group. The right leaf was deficient in nitrogen. Yellowing started at the tip and proceeded down the midrib. In the potassium-deficient leaf in the centre yellowing started at the tip also, but moved down the edges of the leaf, leaving the midrib area green. The left leaf was normal. The inset shows a section of normal and phosphorus-deficient leaves. Note the reddish purple edge on an otherwise dark-green leaf.
(Courtesy Michigan State College).

Mobile and Immobile Nutrients

While it is important to have all nutrients, whether major or minor, present in adequate amounts, we must also consider the "mobility" of these nutrients. Water and nitrate nitrogen are completely mobile. They are not subject to fixation, as the minerals are. They are free to move in the soil.

All other nutrients are relatively immobile, so plant roots must seek them out. They are not in solution, unless in very small amount, but are in fixed positions in the soil, held in a chemical complex. In this form some of them may be available to the plant, but they can't move to the plant. The plant must come to them.

This being so we can see that a plant may not be getting all the phosphate and potash it needs even though the soil contains a surplus of these materials. There must be a large enough excess to make sure of sufficient root contact, if crop yield is to be satisfactory.

Nitrate nitrogen and water, being mobile, can go to the plant roots. Therefore we need no large surplus nor do we want it. A surplus of nitrate nitrogen would be easily leached from the soil and lost. And a *considerable* surplus could be toxic or poisonous, injuring rather than helping plant growth.

But, while only small supplies are needed at a time, our crops do need these small supplies of nitrate nitrogen, and water. And they need them continuously throughout the growing season. We know the results of insufficient rainfall. Growth, and yield are reduced despite good fertility levels. Or water may be in good supply, but nitrogen may be lacking, with adverse crop results.

Hunger Signs in Plants

In the FAO Agricultural Studies booklet, Efficient Use of Fertilizers, there is this discussion of plant-hunger symptoms or signs:

> Plants show characteristic hunger symptoms when any essential element is seriously lacking. Symptoms that can be detected visually include the kind of growth and the coloring assumed by various parts of the plant. The nature of the symptoms varies from crop to crop, it varies with the degree of the deficiency, it is sometimes confused by the effects of plant diseases and insect damage, and it may be complicated by the simultaneous appearance of two or three kinds of deficiencies. Long experience is required to diagnose the symptoms accurately and to write an effective fertilizer prescription. . . .
>
> A further complication in deficiency diagnosis is that recognizable symptoms usually appear only at an advanced stage of malnutrition and at an advanced stage of the plant's growth. Often the symptoms become clear only after it is too late to correct the deficiency with fertilizers for the current crop. Especially on fruits, some deficiencies cannot be corrected by soil fertilization after the plants are well advanced in the season. This is particularly true with mature trees. . . .
>
> Symptoms of a deficiency in any given element are not identical in all crops, but a number of them are of general occurrence and importance. Those listed below, a minimum group, can provide only the barest introduction to this important subject.
>
> The earlier symptoms of *potassium* deficiency are variously expressed in certain crops by small white, yellow, or reddish-brown spots on the leaves, followed by scorching or browning of the leaf edges in such crops as legumes, maize (corn), cotton, and tobacco, and the leaf tips of small grains. In potatoes an abnormally dark-green foliage is a dependable early sign, followed by browning of the leaves.
>
> *Nitrogen* deficiency usually results in reduced plant vigor, in a fairly uniform light-green or yellowish-green leaf color, and in yellowing and dying of lower or older leaves.
>
> *Phosphorus* deficiency often causes stunted growth, delayed ripening, poor fruiting, poor root growth, purpling of the leaves, leaf edges, or stems, and an abnormally dark-green leaf color in some species, including tobacco and cotton. In addition to these symptoms, potatoes show rusty brown lesions on the tubers, first in the form of isolated flecks and then of larger areas as these join together.
>
> *Magnesium* deficiency produces a yellowing (or reddening) which appears first at the tips and margins of leaves and spreads to areas between the leaf veins, especially of older or lower leaves. This symptom distinguishes it from iron chlorosis (loss of green color), which usually starts in new leaves. Eventually the tissue of the affected leaves becomes brown. In maize, magnesium deficiency causes yellowish-white stripes to run the length of the leaves, with the veins remaining green. It may also cause an apparent phosphorus deficiency, especially in oil plants such as linseed and oil palm.

Calcium deficiency causes a distortion of new leaves. The growing point becomes stunted, and yellow and brown areas may develop along leaf margins and between veins.

Lack of *sulphur* results in reduced growth and in leaf-yellowing similar to that caused by nitrogen deficiency. It differs, however, in that it appears first on new growth, and the green veins are slightly more distinct than in nitrogen hunger.

Zinc deficiency causes splotchy yellow and brown leaf coloration, sometimes with darkened veins. In maize (corn), this deficiency causes dwarfing of plants. New leaves emerge whitish in color (a condition that is commonly called "white bud"), and the upper leaves are yellow-striped between the veins.

Boron deficiency causes twisting and distortion of upper leaves and death of the terminal bud. Leaf points and margins may turn brown or reddish-yellow before drying prematurely. In some plants this deficiency causes brittle stems and petioles and internal blackening of fruit and root crops.

Copper deficiency is evidenced by wilting of upper leaves and dying of leaf tips, often without pronounced bleaching or change of color.

In *manganese* deficiency the leaves may be checkered with yellow, dead spots, or they may develop a light green color between the veins, which later spreads over the entire leaf.

Want of *iron* causes leaves to lose green color, especially the upper or new leaves, except along the principal veins, which remain green.

Toxic Effects of Excess Nutrients

Fertilizers containing phosphorus, calcium, magnesium and sulphur generally can be used in large amounts with no harmful effect, unless the nutrient balance is upset. But nitrogen and potassium, which are usually applied in the form of highly soluble salts, may cause injury when used to excess. This is especially so if they are concentrated too close to germinating seed or young seedlings.

As we have seen, plants require boron, copper, iron, manganese, molybdenum, and zinc in very small amounts only. Any excess of any one of them, beyond a narrow range, is likely to be toxic or poisonous to plants, the danger varying with the crop.

For example, cauliflower on sandy soil may need boron. Borax 2 to 4 pounds per acre, will supply the need; but an application of 8 or 9 pounds may injure the crop. A little is good, but more is *not* better, and that is one thing to remember when using trace elements.

Another example. Beets and alfalfa have a relatively high boron requirement. Applications up to 50 pounds per acre of borax may be needed, are not uncommon. But, if beans are grown in rotation with beets and alfalfa, the residue of boron in the soil may injure the bean crop.

Highly organic soils, muck and peat, often need copper, and considerable applications can be made without toxic effects. Yet, on these organic soils, an excessive amount of either copper or manganese may lead to a deficiency of the other.

So, there are dangers in the use of the "minor" or trace elements. Caution is needed. Be governed in part by the nature of your soils and the needs of particular crops. And seek the advice of extension workers competent to diagnose crop needs from plant symptoms.

SOIL TESTING

It isn't good farming to apply fertilizers, either as to analyses or amounts, by guesswork. To some extent you will be able to judge crop needs by the vigour and appearance of your crops, and by yields. But even here you can take out much of the guesswork if you have your soil properly analysed as to the amounts of minerals and nitrogen present. The more intensive the type of farming, the more important it is for you to have this information.

When to Take a Soil Sample

Winter sampling is not recommended but, otherwise, samples may be taken at any time convenient to the farmer. When the ground is frozen or covered with snow it is obviously difficult to take proper respresentative samples. In addition, it may be difficult to see strike-outs or old droppings from cattle, which could markedly influence the sample.

A soil-testing laboratory is usually flooded with samples in April, seriously over-taxing its facilities. To relieve this pressure, and provide a smoothly operating, more efficient service, samples from fields to be sown to spring grain and corn should be sent to the laboratory the previous fall. Samples from fields to be seeded to fall wheat should arrive in the spring.

How to Take a Soil Sample

1. Soils that differ in appearance, previous fertilization, liming, manuring, or crops grown, should be sampled separately, provided they are of sufficient area to be fertilized separately.

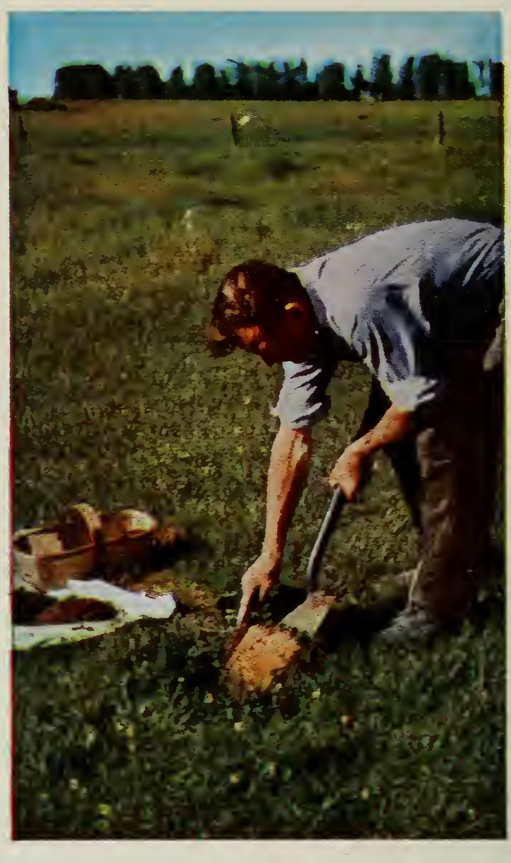
2. Avoid sampling where there has been a pile of manure or other residues, as well as strike-outs and dead furrows. Land close by a heavily travelled gravel road may be affected by road dust.

3. The topsoil sample should represent the whole field. It should be made up of portions taken at 10 to 15 places, depending on the size of the field and the previous treatment. After clearing the surface of trash, make a hole to the dept of the dark top layer (usually 6 to 8 inches). From the straight side take a thin slice to the full depth of the hole. Trim off the sides of the slice leaving a core about 1" thick, 1" wide and 6" long. Place the core in a pail. When all cores from a field have been gathered, break up the lumps with the fingers and thoroughly mix the sample in the pail. It is unnecessary to dry the soil unless it is too wet to mix properly.

Place the sample in the wax paper bag provided with the soil box by your agricultural representative. Do not use paper envelopes or glass bottles for shipping soil samples. If several samples are to be sent at the same time, be sure to number them and keep a record of the numbers.

4. Place the name and address of the sender on the outside of the parcel. This information is required in order to make a recommendation.

FIG. 11. A soil test is a useful and often-times necessary guide to soil fertility. Time and care are necessary to secure a proper soil sample.



5. Fill in carefully the spaces on the form "Information on Soil Samples".

6. Samples should be mailed or expressed PREPAID to the testing station in your area.

Where to Send the Samples

Send samples which concern cereal grains, hay, pasture, corn, roots, potatoes, vegetables (not market gardens), lawns, and home gardens, to the Department of Soils, Ontario Agricultural College, Guelph; The Western Ontario Experimental Farm, Ridgetown; or the Kemptville Agricultural School, Kemptville.

Send samples which concern market gardens and greenhouses, to Department of Horticulture, Ontario Agricultural College, Guelph.

Send samples which concern tree fruits, bush fruits, and small fruits, to: In Eastern Ontario — Kemptville Agricultural School, Kemptville; in Central Ontario — Horticultural Experiment Station, Vineland Station; in Western Ontario — Western Ontario Experimental Farm, Ridgetown.

The efficient use of fertilizers and manures involves soils and their management, crops and their sequence, climate (including supply of moisture), systems of farming, and the farmer's profit. These factors may vary from one locality to another, from farm to farm, and even from field to field.

Efficient Use of Fertilizers, F A O Agricultural Studies.

FERTILIZERS

ORIGIN AND USE OF FERTILIZERS

The use of chemical substances to supplement the native elements contained in soil, is a recent practice, as agricultural history goes. A hundred years ago Sir John Bennett Lawes developed the technique of treating bones with sulphuric acid so as to make the phosphate in bones available to plants. Since then we have made continuous progress in our knowledge of plant nutrition and the use of chemical fertilizers.

Canada uses, currently, well over half a million tons of fertilizers annually, and the trend of usage steadily moves upward. The basic fact remains, however, that, valuable and even essential as fertilizers have proven themselves to be, they can only *supplement* and never *replace* good farm practices, as these are reflected in organic content of the soil, tilth, aeration and drainage.

Organic matter itself is the natural source of nitrogen, and the storehouse of the mineral nutrients. But usually it cannot supply *all* the nitrogen and minerals that your crops can use to advantage. So, we use commercial fertilizers where soil tests and crop growth indicate more plant food is needed.

Organic matter and available plant food go hand in hand as we have seen. Commercial fertilizer is of most value where the level of organic matter is kept high. On organic or muck soils, of course, no additions of organic matter are needed. But organic soils are seldom "balanced" (see page 25) in their supplies of nutrients, and hence need careful use of commercial fertilizers to balance the plant food present naturally. On the other hand, some mineral soils may be well supplied naturally with mineral elements but may lack the organic matter to make these elements available to plants.

New and improved sources of plant food are continually being found. For example, we now have ammonium nitrate and nitrogen solutions which have twice the nitrogen content of the older, more familiar nitrate of soda. Most superphosphate now contains 20 per cent phosphoric acid (P_2O_5) as against the 14 to 16 per cent of a few years ago. And we have double superphosphate with 43 to 48 per cent P_2O_5. The present day 60 per cent muriate of potash (K_2O) has largely taken the place of the old 26 per cent potash.

Fertilizer analyses are stated thus: 2-12-10, 0-12-20. The first number in each analysis represents the percentage of total nitrogen (N); the second represents the percentage of available phosphoric acid (P_2O_5); and the third represents the percentage of water soluble potash (K_2O).

HIGHER ANALYSES FERTILIZERS

Twenty years ago 2-8-4 was a popular fertilizer in Ontario, but it has now been completely discarded. First it was replaced by 2-12-6, and now 2-12-6 has gone and we have 3-18-9 and 4-24-12. Other analyses now sold may also disappear in favour of more concentrated plant food.

There are reasons why we should welcome more concentrated fertilizers. Freight and truck rates have increased greatly in the past few years. More concentrated fertilizers mean that each ton contains more actual plant food and therefore we are not paying so much freight on "filler".

It is true that the cost *per ton* of the more concentrated fertilizers is higher but the cost *per unit of plant food* is lower. In addition, fewer pounds per acre are needed of the more concentrated fertilizer. Where you now use 20 per cent superphosphate at 300 lb. per acre, in the near future you will handle only 150 lb. per acre of 44 per cent double superphosphate. This is a saving in time and labour.

NITROGEN EQUIVALENT TABLE

You will find the term "nitrogen equivalent" used often. Table 4 shows what is meant. For example, 100 lb. ammonium nitrate is equal to 160 lb. ammonium sulphate, or calcium cyanamide, and 200 lb. nitrate of soda.

TABLE 4. APPROXIMATE NITROGEN EQUIVALENTS

Ammonium Nitrate 33% N	Ammonium Sulphate 20% N	Calcium Cyanamide 20% N	Nitrate of Soda 16 % N
50 lb.	80 lb.	80 lb.	100 lb.
100 lb.	160 lb.	160 lb.	200 lb.
150 lb.	240 lb.	240 lb.	300 lb.
200 lb.	320 lb.	320 lb.	400 lb.
250 lb.	400 lb.	400 lb.	500 lb.

METHODS OF APPLYING FERTILIZERS

Once it has been decided which materials are to be used on which field and crops, the important problem of determining how and when the job should be done to obtain the best results still remains. It is not enough to apply the right kind and amount of fertilizer, manure, or soil amendment. If these materials are to be used most efficiently, they must also be applied at the right time and in the right way. This is particularly important when a short supply of fertilizers must be used to obtain optimum increases in crop yields.*

There is no one method of applying fertilizers which will best suit all requirements of your crops and soils. The underlying principle, however, is to place the fertilizer so that it will be available to the plant when it is most needed. Thus the "position" of the fertilizer may be just as important as analysis and amount. Some of the better known methods are described and one of these or a combination of one or more should give you satisfactory results.

Broadcasting or Top-dressing Without Working into the Soil

For such crops as hay and pasture this is a practical method. You may use a fertilizer drill, a lime or fertilizer spreader, or a cyclone spreader; or you may spread the fertilizer by hand on small areas or in orchards. Apply in fall or early spring when moisture is abundant, since, to be effective, these fertilizers must reach the root area of the plant.

* Efficient Use of Fertilizers, F A O Agricultural Studies.

Broadcasting and Working into the Soil

If you plan to broadcast heavy applications, put about two-thirds of the fertilizer on at soil-preparation time, and work it into the soil. Apply the remaining third at crop-planting time.

When green-manure crops, corn stubble, straw or other crop refuse are trash disked (see page 15, Trash Cultivation) or plowed under in summer or fall, it is sometimes desirable to hasten decomposition. This you may do by broadcasting some form of nitrogen prior to disking or plowing. Calcium cyanamide is useful for this purpose. Apply 100 to 300 pounds per acre, depending upon the amount of plant material, and the crop to follow. When you plow-down material in the spring use ammonium nitrate, sulphate of ammonia, or a complete fertilizer high in nitrogen.

Banding

An effective way of applying fertilizer is to place it in bands to the side of, and slightly below, the plant or seed. Suitable machines adapted to the needs of farm and garden crops are on the market for this purpose.

Drilling

The most common practice is to apply the fertilizer with the combination grain and seed drill at time of planting. For small grains you will find this method superior to separate application, whether broadcast or drilled.

Mixing Fertilizer with the Seed

You may not have a fertilizer drill. You can mix granular high-analyses fertilizers with the seed, (for some, but not all crops), but you must sow immediately to avoid fertilizer injury to germinating seed.

Side Dressing

Row-crops are sometimes side dressed during the growing season. For time of application see specific crop instructions (pages 37 to 64). The usual method is to apply the fertilizer 4 to 6 inches from the growing plant, and cultivate immediately. Nitrogen and potash fertilizers are frequently used in this way. While you may side dress by hand, a fertilizer attachment to the single-row cultivator is recommended. Side-dressing applications depend upon rainfall or irrigation to dissolve the fertilizer applied.

Phosphated Manure

If you use superphosphate in your stables, (see page 13 under "Manures"), applications of superphosphate to crops receiving this phosphated manure may be reduced proportionately.

Fertilizers in Solution

Fertilizers used in solution are recommended chiefly when transplanting certain vegetable crops such as tomatoes. Also they are useful in applying nutrients to plants in flats, and potted house plants. The numerous commercial solutions and soluble powders on the market should be used according to the manufacturer's directions.

You can prepare a good home-mix solution as follows: — 100 pounds of ammonium phosphate (11-48-0), 50 pounds of ammonium sulphate (20%), 50 pounds of muriate of potash (60%). On a dry basis such a mixture has an approximate analysis of 10-24-15. Dissolve in 40 gallons of water, stir, and allow the sediment to settle. For use, dilute one gallon of the clear stock solution in 250 gallons of water.

Apply the diluted solution at the rate of one cup per plant, or one pint per square foot of flat or bench space. As a booster solution in the field for crops such as tomatoes, peppers and egg plants, use three gallons of the clear stock solution to 250 gallons of water.

Indirect Application

Good farm practice requires that land should be under vegetation whenever possible. Vegetation reduces soil erosion and maintains or builds up organic matter with its many benefits. When cover crops are well fertilized with a high-nitrogen fertilizer to promote rapid growth the resulting organic matter, being rich in minerals and nitrogen, is of additional benefit to the succeeding crop.

Foliar Applications

Leaves are able to absorb certain nutrients applied as a spray or dust. Ordinary fertilizer materials are not commonly applied in this way; special fertilizer chemicals wholly soluble in water, or special dusts, are used.

We are dealing with absorption in *small* quantities, and not full crop needs. Where only small quantities of nutrients are required spraying has an advantage. Since the nutrients are absorbed through the leaves, they are effective almost immediately. Also, nutrient sprays can be combined with pest control sprays. However, spraying of nutrients only temporarily corrects nutrient shortages. It must be repeated several times in a season if the deficiency is severe.

Sometimes some deficiencies, especially in shrubs and trees, are more easily controlled by nutrient sprays than by soil applications. Partly, this is because of the high capacity of some soils to fix mineral nutrients, making them unavailable to the plant. In fact, it is difficult to correct soil deficiencies of the trace elements in mature fruit trees by soil additions of fertilizers. Iron and zinc are common examples.

Because of the cost it is not practical for you to try to meet *all* the plant food requirements of your crops by foliar applications. In fact, you cannot apply adequate amounts of the major elements, nitrogen, phosphorus and potassium because you must work with quite weak solutions. Too-concentrated a solution, necessary to supply sufficient of the nutrients, will cause severe leaf burn. A safely weak solution will require an unduly large volume of solution, or a large number of spraying operations during the season.

Further to the *general* use of foliar applications of nutrients, Michigan* reports as follows:

Foliar applications of nitrogen, phosphorus, potassium, magnesium, manganese, boron and zinc, as sprays or dusts, were made in 1950, 1951, and 1952, to onions, table beets, sugar beets, potatoes, and celery.

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* Michigan State College, Quarterly Bulletin, Vol. 35, No. 3. Feb. 1953.

Table 5

TERMS FREQUENTLY USED IN FERTILIZER WORK

B	Boron (Borax, $Na_2B_4O_7$; Boric Acid, H_3BO_3).
Ca	Calcium, the basis of lime.
$CaCN_2$	Cyanamide, 20% N. and 70% Ca.
$CaCO_3$	Calcium carbonate, Agricultural lime, Air-slaked lime.
$CaCO_3 . MgCO_3$	Dolomitic limestone.
CaO	Calcium oxide, Quicklime.
$Ca(OH)_2$	Hydrated lime.
$CaSO_4$	Calcium sulphate, Gypsum, Landplaster.
Cu	Copper.
$CuSO_4$	Copper sulphate, Bluestone.
Fe	Iron.
$FeSO_4$	Iron sulphate, Ferrous sulphate, Copperas.
K	Potassium.
KCl	Potassium chloride, Muriate of potash, 50 and 60% K_2O.
K_2CO_3	Potassium carbonate, a constituent of wood ashes.
KNO_3	Potassium nitrate, Saltpetre, 13%N. and 44% K_2O.
K_2O	Potassium oxide, the "Potash" of fertilizers.
K_2SO_4	Potassium sulphate, 48% K_2O.
Mg	Magnesium.
$MgCO_3$	Magnesium carbonate, constituent of dolomitic limestone.
MgO	Magnesium oxide, Magnesia.
$MgSO_4$	Magnesium sulphate (Epsom salts).
$MgSO_4 . K_2SO_4$	Sulphate of potash magnesia, Sulpho-Mag.
Mn	Manganese.
$MnSO_4$	Manganese sulphate.
Mo	Molybdenum.
N	Nitrogen.
Na	Sodium.
$NaMoO_4$	Sodium Molybdate.
$NaNO_3$	Sodium nitrate, Nitrate of soda, 16% N.
NH_3	Ammonia.
NH_4NO_3	Ammonium nitrate (Nitraprills), (Aeroprills), 33.5% N.
$(NH_4)_2SO_4$	Ammonium sulphate, 20% N.
NO_3	Nitrate.
P	Phosphorus.
P_2O_5	Phosphorus pentoxide, "Phosphoric acid" of fertilizers.
S	Sulphur.
Zn	Zinc.

In general, higher crop yields were obtained from soil applications than from foliar applications of nitrogen.

Phosphorus applied as a spray to onions and celery did not increase yields, and in 1952 there was some evidence of reduced yield.

Zinc sprays caused a significant reduction in yield of onions and lower yields of potatoes in 1952.

There were no significant differences in manganese responses, due to methods of applying.

The addition of 4 pounds of magnesium sulphate, 2 pounds of manganese sulphate, and 1 pound of borax per 100 gallons of spray increased the yield of potatoes by 100 bushels per acre in 1952. It is not known which of the three elements or combination of elements was responsible for the yield increase.

In summary, the Michigan item concludes — "Foliar application of plant nutrients should in general be considered as supplemental to the regular soil fertilization program".

FERTILIZER ANALYSES

These fertilizers analyses appear in the specific recommendations for various crops, pages 37 to 66.

GENERAL FERTILIZERS:

0-16-8
0-12-12
0-12-20

2-8-16
2-12-10
2-12-16
2-12-20
2-16-6

3-12-6
3-18-9

4-12-6
4-12-10
4-24-12
5-10-13

10-5-10
10-6-4
10-10-10
12-24-12

TOBACCO:

2-10-8
2-12-10

3-10-8
3-15-12
3-18-15

5-10-13

Higher analyses mixtures of equivalent ratios of any of the above, are equally acceptable. For example, note that 4-24-12 is the same ratio (1-6-3) of plant food as 3-18-9. Also, 5-10-13 is essentially the same ratio as the old 4-8-10.

MATERIALS:

Ammonium nitrate, 33% N.
Ammonium phosphate, 16% N. and 20% P_2O_5 (16-20-0).
Ammonium phosphate, 11% N. and 48% P_2O_5 (11-48-0).
Ammonium sulphate, 20% N.
Calcium cyanamide, 20% N. (cyanamide, cyanamid).
Nitrate of soda, 16% N.
Potassium chloride (muriate of potash) 50% and 60% K_2O.
Potassium nitrate, 13% N. and 44% K_2O (13-0-44)
Potassium sulphate, 48% K_2O.
Sulphate of potash magnesia, 22% K_2O, and 16 to 18% MgO.
Superphosphate, 20% P_2O_5. "Double" superphosphate, 43 to 48% P_2O_5.
Phosphate rock. A natural rock containing calcium phosphate, and used either directly or, after concentration, in the manufacture of commercial products.

RECOMMENDATIONS FOR SPECIFIC CROPS

CEREAL, HAY AND PASTURE CROPS

General Considerations

The influence of fertilizers on the catch of clovers and grasses seeded with cereals, and the residual effect on succeeding crops, may be as important as the more immediate effect on the cereal crop. Also, proper use of fertilizer offers substantial insurance against winter killing of fall-sown grains and hay crops.

Fertilizers for cereal crops, not including peas, (see page 38, Field Peas) should be applied in the drill row with a combination fertilizer drill, or with a fertilizer attachment on the drill, rather than by broadcast application.

Hay and pasture crops are harvested in the immature stage and are utilized from early spring until late autumn. They use plant food for their entire life cycle but, when pastured, there is a considerable return of fertility through droppings and urine.

Most hay and pasture crops are mixtures of different species of grasses and/or legumes, whose growth habits and food requirements may vary rather widely. Because of these facts the rate and method of application of manure and chemical plant-foods may differ considerably from the recommendations for cereal crops.

In the past considerable stress has been placed on the belief that nitrogenous fertilizers produce lodging in grain crops. Since there is little or no evidence to prove this point it is felt that, under most circumstances, the accompanying recommendations will be found satisfactory for grain crops.

While the specific fertility needs of the soil may be more accurately determined by chemical tests (see page 29, Soil Testing) the following general fertilizer mixtures and rates are suggested as guides, suitable for most farms; but more may be used in some cases and possibly less in others.

Fall-sown Grains — Wheat, Barley, Rye

For fall-sown grain use 2-12-10 or 3-18-9 at 300 to 400 pounds per acre, or 4-24-12 at 225 to 300 pounds per acre. If the crop lacks vigour in the spring an application of nitrogenous fertilizer (50 to 100 pounds of ammonium nitrate or its equivalent) is recommended, and should be applied just when growth commences early in the spring. Where an adequate amount of farm manure is used in the crop rotation, an application of 20% superphosphate at 200 to 300 pounds per acre may be all the fertilizer necessary.

Where hay or pasture is to follow the grain, the fall-sown crop may be under-sown with suitable seed mixtures. Grasses may be fall seeded at the time of seeding the grain. Clovers, however, thrive better when spring sown. Where grasses and clovers are to be seeded the rate of fertilizer application should be increased to 350 to 500 pounds of 2-12-10 or 3-18-9, or 260 to 375 pounds of 4-24-12 per acre in the fall at the time of seeding the grain.

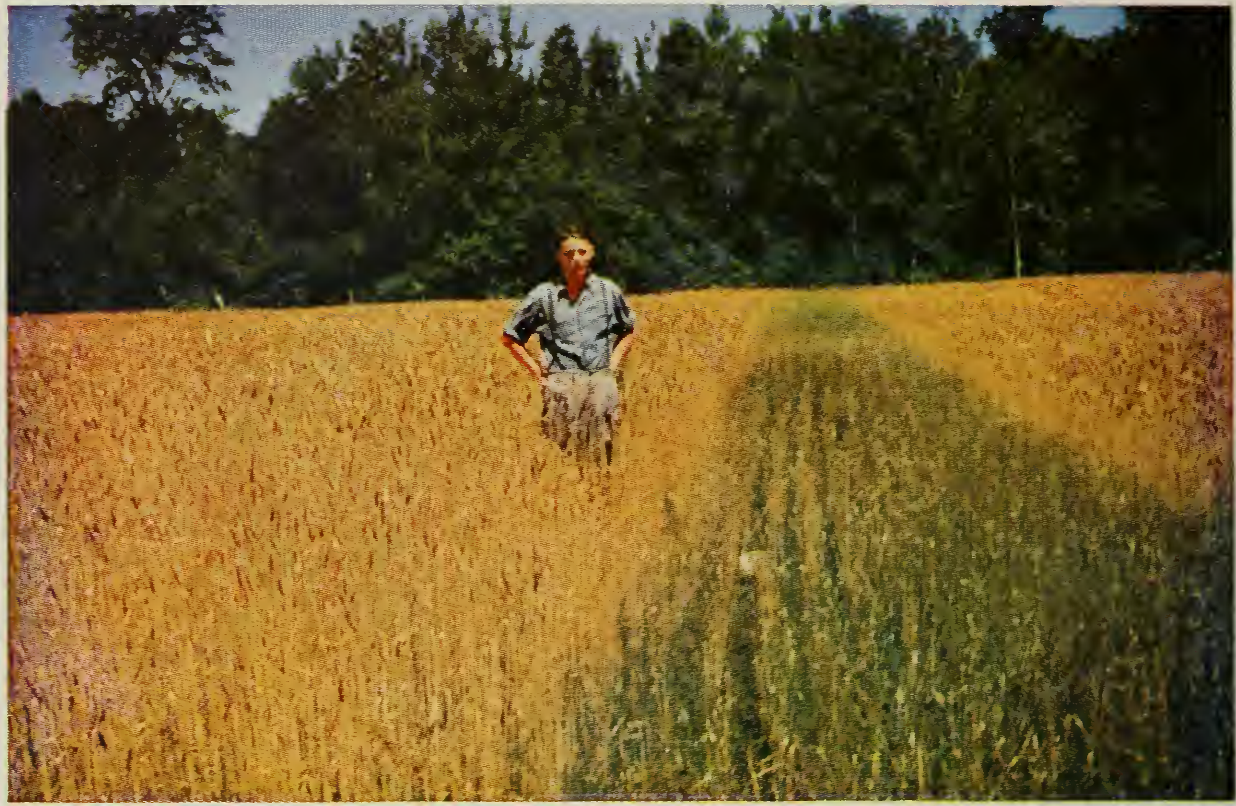

FIG. 12. Fertilizers supplement good farm practice. They do not replace it. The need for fertilizers is often indicated by reduced vigour and yield as in the unfertilized grain plot above (right).

Spring-sown Grain — Wheat, Oats, Barley Buckwheat — Not Seeded Down

When seeding the spring grain crop alone, use 4-12-6 at 300 to 400 pounds per acre. Where the supply of manure in the rotation is limited the fertilizer rate should be increased to 350 to 500 pounds.

Spring-sown Grains, Seeded Down

When spring grains are to be used as a nurse crop, use 2-12-10 or 3-18-9 at 350 to 500 pounds per acre, or 4-24-12 at 260 to 375 pounds per acre. Clover and alfalfa are generally responsive to mineral fertilizer, and an additional application of 0-16-8 or 0-12-12 at 250 to 300 pounds per acre, after the nurse crop is removed, will usually prove useful.

Field Peas

For field peas apply either 0-12-12 or 2-12-10 at 300 to 400 pounds per acre. Since the germination of peas is affected by close contact with fertilizer it is preferable that the fertilizer should be drilled-in previous to sowing the crop, and at a slightly greater depth than that at which the seed is to be sown.

Flax

On heavy, fine-textured clay soil which is well manured no commercial fertilizer is necessary. The farmyard manure should be applied in the rotation two years before the flax crop. Where manure is scarce or unavailable, an application of 2-12-10 at 300 to 400 pounds per acre is recommended for fibre flax. For linseed flax unmanured, an application of 3-18-9 at 300 to 400 pounds per acre is recommended.

TABLE 6. CEREAL CROPS. FERTILIZER RECOMMENDATIONS

Crop	Not Seeded Down Analysis[1]	lb. per acre	Seeded Down Analysis[1]	lb. per acre
Fall-sown Grains[2, 3]	2-12-10	300-400	2-12-10	350-500
(wheat, barley, rye)	or 3-18-9	300-400	or 3-18-9	350-500
	or 4-24-12	225-300	or 4-24-12	260-375
Spring-sown Grains[3, 4]	4-12-6	300-400	2-12-10	350-500
(wheat, oats, barley, buckwheat)			or 3-18-9	350-500
			or 4-24-12	260-375
Field Peas	0-12-12	300-400		
	or 2-12-10	300-400		
Flax for Fibre				
(a) Manured	No fertilizer needed			
(b) Unmanured	2-12-10	300-400		
Flax for Linseed Oil				
(a) Manured	No fertilizer needed			
(b) Unmanured	3-18-9	300-400		

1. When more than one fertilizer mixture is mentioned use *one only.*
2. If fall-sown grains lack vigour in the spring, apply per acre, 50 to 100 pounds of ammonium nitrate or equivalent. Where an adequate amount of manure has been applied in the rotation, 20 per cent superphosphate at 200 to 300 pounds per acre may be all the fertilizer necessary.
3. When the seeded-down crop is a legume. after the nurse crop is removed apply either 0-12-12 or 0-16-8 at 250 to 300 pounds per acre.
4. Where manure is limited increase the 4-12-6 rate to 350 to 500 pounds per acre.

Hay and Pasture Crops

Seeded without a nurse crop. Use the same fertilizer formulae and amounts as when a nurse crop is used; i.e., as above, for spring-sown grains, seeded down. (See also table 6).

Method and time of application for established stands. Broadcast application is the method most commonly used, and is satisfactory.

Late September or early October is usually preferred for the application of mineral fertilizers. However, spring application just as growth is commencing, is satisfactory provided there is sufficient rain to dissolve and move the fertilizer into the root region.

Applications of nitrogen, separate from the minerals, are applied to best advantage early in the spring. Midsummer applications of nitrogen are effective if adequate moisture is present.

Renovating Old Pastures

(a) Unplowable. Top dressing with fertilizers only, is usually unsatisfactory unless the soil is deep, productive, and already covered with a good stand of suitable grasses, or a mixture of grasses and legumes.

FIG. 13. When properly managed and fertilized, hay is one of the most economical sources of feed.

FIG. 14. Good pasture produces milk and beef at low cost, for 4 to 6 months of the year.

If the sod is thin, the first heavy application of fertilizer will thicken the stand, and a second application will give better returns than the first. If such areas are very weedy, reseeding by any suitable method is advisable.

(b) Plowable. Where old pastures are plowable it is usually much more satisfactory, especially if they have become thin and weedy, to plow the area and reseed with a suitable mixture of grasses and legumes. Apply lime, if needed, in the fall immediately after plowing. Fertilize as directed under the section, Spring-sown Grains, Seeded Down.

Maintaining Established Stands

There is little difference in the basic fertility requirements of the various species of grasses or the different species of legumes used for hay or pasture. However, inherent differences in soil types, and pasture fertility or grazing management, will affect the choice and rate of application of fertilizers. The following rates and analyses are suggested for the conditions mentioned.

Where grasses dominate. On both light and heavy soils apply manure, 6 to 8 tons per acre, in the fall every 3 years. In the early spring, every 3 years, apply 300 to 600 pounds per acre of 4-12-6.

On light soils, not manured, in the fall, every 3 years apply 400 to 600 pounds per acre of either 0-12-12 or 2-12-10. In the spring apply 100 to 300 pounds per acre of ammonium nitrate or its equivalent. If, on these soils, spring application of fertilizers is more practical apply 300 to 600 pounds of 10-10-10 every 3 years.

On fine-textured clay soils, not manured, apply 300 to 600 pounds per acre of 0-16-8 in the fall, every 3 years. The following spring supplement this application with 100 to 300 pounds of ammonium nitrate or equivalent. Or, if spring application of a complete fertilizer is preferred, apply 4-12-6 at 400 to 600 pounds per acre every 3 years.

For clay soils well supplied with organic matter and available potassium, it is sufficient to apply, in the spring every 3 years, 400 to 600 pounds superphosphate (0-20-0), plus 75 to 100 pounds ammonium nitrate or equivalent.

Where legumes dominate. Legumes are generally not tolerant of acid conditions so soils should be limed at rates indicated by soil tests.

Light soils should receive an application of 300 to 600 pounds per acre of 0-12-12 or 0-12-20, in the fall, every three years. For heavy soils the recommendation is 300 to 600 pounds per acre of either 0-16-8, or 20 per cent superphosphate, applied in the fall, every three years. If manure is available a top dressing of 6 to 8 tons per acre of re-enforced manure (see page 33, Phosphated Manure) annually in fall or early winter is quite satisfactory.

Mixtures of grasses and legumes. Where mixtures of grasses and legumes form the hay or pasture crop a complete fertilizer is usually satisfactory. On light soils an application of 300 to 600 pounds per acre of 4-12-10 or 5-10-13 in early spring, every three years, is recommended. On clay soils apply 300 to 600 pounds of 4-12-6 or 3-18-9, or 225 to 450 pounds of 4-24-12 in the spring, every three years.

To promote uniform grazing, especially on rather heavily stocked pastures, droppings should be spread by harrowing at least once a year. This should be done in September or October. Some people like to make an additional harrowing in July. Fall or winter applications of manure should be harrowed in the early spring for thorough distribution and incorporation into the topsoil to prevent smothering or uneven grazing.

While there are instances that fertilizer does not increase the nutritional value of the hay or pasture the general weight of evidence is that it does. Numerous observations indicate that cattle show preference for fertilized pasture areas. Probably the original level of soil fertility is a determining factor.

Soil Conservation Value of a Good Hay-Pasture

There is usually a direct relationship between the vigour of top and root growth. Good soil fertility encourages maximum root growth thus increasing the soil organic matter. By promoting strong top growth the soil is protected from the hot sun, the leaves protect the soil from the beating action of heavy rains, reducing erosion, and the consequent improved physical condition of the soil assists in the absorption of rain or snow.

TABLE 7. HAY AND PASTURE CROPS. FERTILIZER RECOMMENDATIONS

Hay and Pasture Type	Analyses and Rates			
	Light Soils		Heavy Soils	
	Analysis (2)	lb. per acre	Analysis (2)	lb. per acre
At Seeding Time With or Without	2-12-10	350-500	2-12-10	350-500
a Nurse Crop or	3-18-9	350-500	or 3-18-9	350-500
or	4-24-12	260-375	or 4-24-12	260-375
Established Stands, (1) Grasses Dominant				
A. Fall manured every 3 years	4-12-6	300-600	4-12-6	300-600
B. Not manured	0-12-12 (3)	400-600	0-16-8 (3)	300-600
(a) Fertilizer fall applied or	2-12-10 (3)	400-600		
(b) Fertilizer spring applied	10-10-10	300-600	4-12-6	400-600
			or 0-20-0 (4)	400-600
Established Stands, (1)	0-12-12	300-600	0-20-0 (5)	300-600
Legumes Dominant or	0-12-20	300-600	or 0-16-8 (5)	300-600
Established Stands, (1)	4-12-10	300-600	3-18-9	300-600
Mixtures of Grasses and Legumes or	5-10-13	300-600	or 4-12-6	300-600
			or 4-24-12	225-450

1. See text, page 41. Note that for Established Stands, fertilizer is applied every *third* year only.
2. Where more than one fertilizer is mentioned use *one only.*
3. Where fertilizer is fall-applied, make a spring application of 100 to 300 pounds per acre of ammonium nitrate or equivalent.
4. Use, in addition, 75 to 100 pounds of ammonium nitrate or equivalent.
5. Or, in place of 0-20-0, (20 per cent superphosphate) or 0-16-8, apply six to eight loads of re-enforced manure annually in fall or early winter.

INTERTILLED CROPS

Field Beans

Field beans grow well following clover sod which has been manured. This treatment may be supplemented to advantage with 150 to 300 pounds per acre of 2-12-10 or 3-18-9, drilled-in with a combined fertilizer and grain drill. Special care should be taken to avoid contact between the seed and fertilizer in planting as bean seedlings are easily damaged by direct contact with fertilizer, especially if the weather is dry after planting.

Soybeans

Soybeans are heavy users of calcium, phosphorus and potassium. On well-limed soils seed inoculation is more effective, and nitrogen fixation from atmospheric sources is more efficient. Inoculation each time the crop is planted has given profitable returns. The availability of lime can be the limiting factor in success of inoculation.

Under average conditions apply 200 to 400 pounds per acre of 2-12-10. If soybeans follow a good clover sod in the rotation an 0-12-12 mixture is recommended to prevent lodging. Avoid contact between the seed and fertilizer.

Sugar Beets

Corn generally responds well to an application of phosphated manure. However, it grows best following a well-manured clover sod. If the manure application is inadequate apply a fertilizer high in phosphate and potash such as 0-16-8, 0-12-12, 2-12-10. Applying the fertilizer to the clover crop in the rotation improves that crop, and this usually results in a higher yield of corn.

When a good clover sod does not precede the corn, use fertilizers containing nitrogen such as 3-18-9, 4-12-10, or 10-10-10 at 300 to 500 pounds per acre. Later, when the corn is 12 to 16 inches high side dress with 100 to 200 pounds per acre of ammonium nitrate or its equivalent.

If both corn and fertilizers are sown with a combined grain and fertilizer drill, it is preferable to apply the fertilizer only through the tubes that are not seeding corn. When a corn planter is used, the fertilizer should be sown on each side of the seed-shoe rather than in the tube with the seed. Fairly heavy applications of fertilizer applied with the seed tend to burn the seedlings, especially in dry weather.

After harvesting the ears of husking corn the stalks should be incorporated with the soil either by plowing or disking. To speed decomposition apply 75 to 100 pounds per acre of cyanamide or its equivalent, immediately before plowing or disking. This soil treatment will favorably influence the next crop in the rotation.

Field Corn

A rotation which includes legume crops is essential. Increased yields are obtained when beets follow legumes and where liberal quantities of manure have been applied. Although fertilizers do not take the place of organic matter obtained from clover and manure, their use generally gives

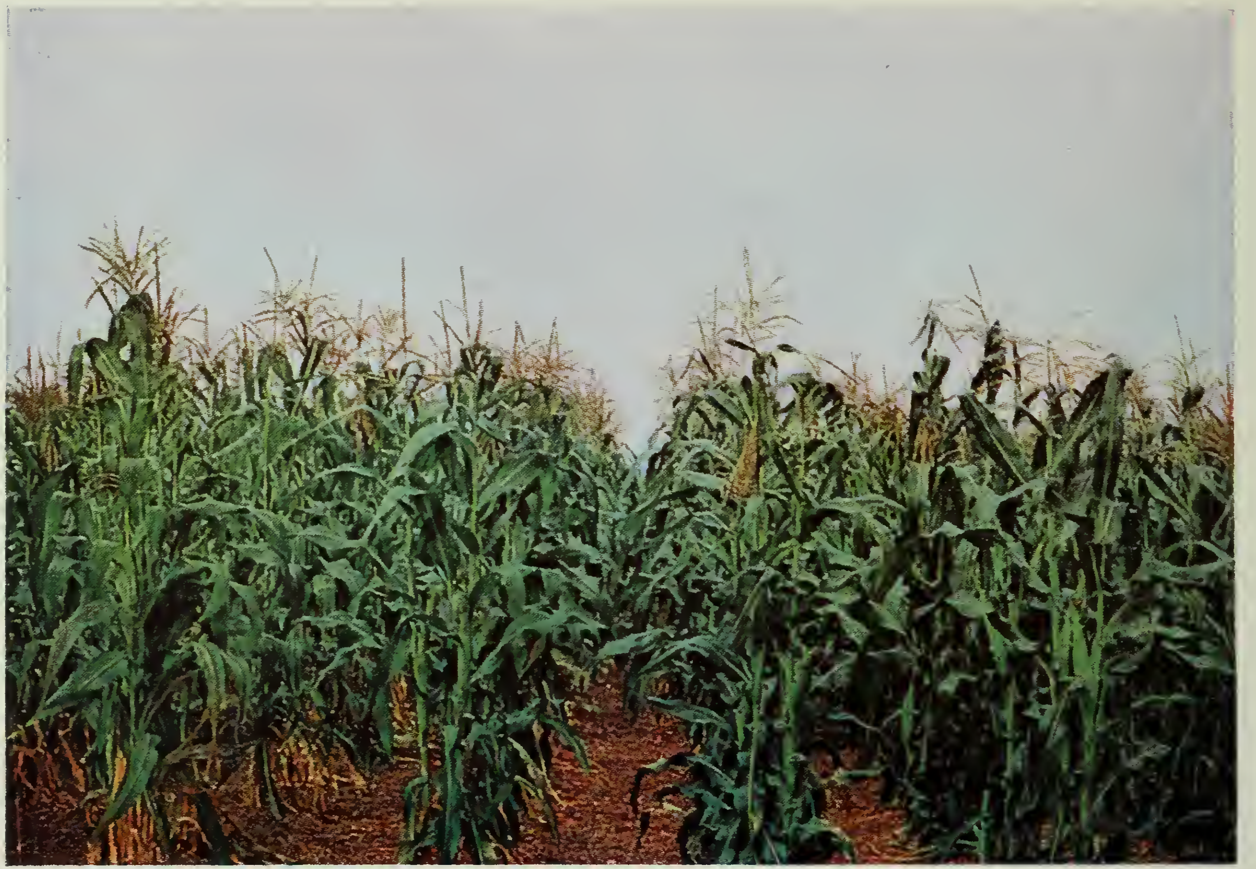

FIG. 15. Field corn and nitrogen. The rows on the left lack sufficient nitrogen. A side-dressing of 100 to 200 pounds per acre of ammonium nitrate, when the corn was 12 to 16 inches high, would have corrected this, produced corn like the rows on the right.

increased yields. Fertilizers high in phosphate are usually found to give increased returns, but the fertilizer analysis used should be based upon soil tests. A 2-16-6 has proven very satisfactory for soils low in phosphate, and 2-12-10 is recommended for lighter soils where potash is low. Superphosphate gives excellent results on marl soils and other soils high in organic matter and well supplied with potash.

A total fertilizer application of 400 to 600 pounds per acre is recommended. Applications are most effective in the row but not more than 300 pounds of the total amount should be applied in contact with the seed. New types of beet drills separate the seed and fertilizer. The ideal placement of fertilizer is about ½ inch to the side and 1½ to 2 inches deep. Unless the seed and fertilizer are separated, additional applications of fertilizer should be made with a grain drill, a broadcasting device, or applied as a side-dressing at the time of early cultivation.

Borax — Apply 20 pounds per acre on soils where heart rot has appeared previously. If borax is mixed in the fertilizer and is applied in contact with the seed, do not use over 5 pounds of borax per 100 pounds of fertilizer because of possible seed-germination injury.

Fungicidal fertilizer — Good results in the control of black root, a disease of the root at early growth stage, have been obtained by treating the fertilizer with 1 per cent Thiram. This fungicidal fertilizer must be applied at the time of seeding.

Mangels

The mangel is a heavy feeder, resembling the sugar beet in its fertilizer requirements. Under average conditions apply 12 to 15 tons of manure per acre, plus 375 to 500 pounds of 3-18-9 or 2-12-10.

Turnips (Rutabaga)

Under average conditions apply 10 to 12 tons of farm manure, and 375 to 500 pounds per acre of 0-16-8, or 2-12-10, as indicated by soil test. Where phosphorus is deficient use superphosphate in addition, preferably with the manure.

Where water core or brown heart of turnips has occurred previously it is good protection to spray the turnips with a solution of borax to which a spreader and sticker have been added. A dust containing similar ingredients may also be used.

In certain localities, mostly in areas of slightly acid soils, good results have been obtained by adding sufficient granulated borax to the regular fertilizer to give a borax application of 15 to 20 pounds per acre.

For particulars on mixing and applying borax to turnips see Extension Circular 68, Guide to Crop Production in Ontario.

Late Potatoes

The potato plant, like its close relatives, tomato and tobacco. is sensitive to climate, soil, and nutrition. It thrives best in regions where the temperature is cool, humid, and rainfall adequate; and on well-drained sand or loam soils with a pH range of 4.8 to 6.5, well provided with organic matter and plant food.

Organic matter, so important for potato soils, can best be provided by legume residues in the rotation, farmyard manure, and well-fertilized green-manure crops. With lighter types of soil, such organic material should be mixed with the soil by trash disking rather than plowing under. This may require a special type of disk. If such an implement is not available. the grower may have to resort to plowing-under the manure or the green-manure crop.

Where soil and drainage conditions permit, legumes should precede the potato crop. Manure may be applied to the legume crop in late winter or early spring, or application may be made after the hay crop has been removed. Then, the second growth should be allowed to develop well. Trash disk (preferably) the manured legume sod during the latter part of August. Sow to winter rye in early September, 3 bushels per acre. Fertilize with at least 300 to 500 pounds of 2-12-10 per acre.

The following spring, this rye green-manure crop should be either disked in or plowed under before it has reached a height of 12 inches. If it has been impossible to apply the manure to the legume crop the previous season it may be applied previous to disking or plowing-under the rye green-manure crop, provided that the manure has been well rotted.

The potato is a heavy feeder (see Table 1, page 20). Moreover, its nutrients must be absorbed in a short period of time. Generally speaking, 70 per cent of its plant-food requirements are absorbed in the period 50 to 80 days after planting. This suggests that a good portion of the nutrient should

FIG. 16. This good potato crop is no accident. The potato requires a well-drained soil high in organic matter, and is a heavy feeder, needing plenty of plant food and moisture.

be placed at or near plow depth, where the bulk of plant roots are found at this stage in the growth of the potato.

The kind and amount of fertilizer can be more wisely chosen if soils are tested periodically. Also, if fertilizers are to be used in heavy amounts, increase the rate of application of 2-12-10 to the preceding legume or rye crop. This is preferable to increasing the 800 to 1200 pounds per acre (see below) at potato planting time. Too heavy amounts at this time may adversely affect quality.

As a general recommendation for sand or loam soils, where soil testing has not been carried out, use 5-10-13 or 4-12-10 at 800 to 1200 pounds per acre, or comparable mixtures at adjusted rates.

Advantages of the foregoing soil-management and fertilizer suggestions are —

(1) The legume crop and the green-manure crop are both likely to benefit from the heavy applications of fertilizers.
(2) At least some part of the applied nutrients is held in a desirable organic form with little danger of leaching.
(3) Much of the applied plant-food is placed at plow depth, in a moist zone, and available for the plant when it is needed most.
(4) The danger of damaging the quality of the potato tuber by an excess concentration of fertilizers is likely to be diminished.
(5) It must not be overlooked that the heavy applications of fertilizer will result in greater residual effects in the succeeding crops.

The preferred method of applying fertilizers at planting time is by using a potato planter with fertilizer attachment, which should place the fertilizer slightly below and to each side of the potato seed-piece.

Early Potatoes — Field Crop

Early potatoes are grown on a variety of soils ranging from light sands to gravelly loams. While recommended rates of application may vary greatly depending on the type of soil and the available moisture supplies, the 5-10-13 analysis has proven satisfactory for practically all types of early potato soils.

For light-colored sandy soil, and gravelly loams use 5-10-13 at 800 to 1000 pounds per acre.

For dark-colored sandy soils use 5-10-13 at 1000 to 1500 pounds per acre.

Comparable mixtures at adjusted rates may be used in place of 5-10-13.

These recommendations are, as indicated, for early potatoes grown as a field crop. For recommendations covering early potatoes as a market garden crop consult the section Market Garden Crops, page 59.

TOBACCO

General Considerations

Soil organic matter in an active form is vitally important in tobacco production. Suitable crop rotations, cover crops, and rest crops provide this organic matter, reduce leaching of plant nutrients, and check soil erosion.

The fertilization of green-manure and cover crops, and the use of nitrogen on crop residues, assists in maintaining organic matter. Ammonium nitrate (125 pounds per acre) or its equivalent, applied when disking-in the mature crop of rye during the month of August, will reduce the need for farm manure and improve the *flue-cured* tobacco crop that follows. Where the soil is low in potash apply 100 pounds per acre of muriate of potash in addition to the nitrogen. A complete fertilizer high in both nitrogen and potash, such as 10-5-10, may be used as an alternative.

Fertilizer for the tobacco crop supplements and balances the plant food in active organic matter. Efficient use of fertilizer is influenced by the amount and type of organic matter present as a result of the crop rotation, soil type, manure applications, cultural methods, and by the incidence of disease. These factors should be considered in determining the fertilizer analysis to use for tobacco, and the rate of application.

Methods of Application

The fertilizer for *flue-cured* tobacco is best applied at transplanting time in bands about 4 inches to each side of the row, and on a level with, or slightly below the root crown (3 to 4 inches deep). If the application is made in the row before planting, it should be thoroughly mixed with the soil a week before transplanting in order to avoid fertilizer burn. Delayed applications of fertilizer have increased both yield and quality of *burley* tobacco. If the fertilizer for burley is applied with a grain-drill attachment it should be drilled-in 3 to 4 inches deep. Broadcasting and disking is wasteful of material and is not recommended.

FIG. 17. The management of tobacco soils requires very watchful attention to organic matter, and the use of specially compounded fertilizers in carefully determined amounts.

Sources of Plant Nutrient Materials

Special attention is required in choosing materials for making commercial fertilizer for tobacco. Results of experiments indicate an advantage in using more than one source of nitrogen. Approximately one-quarter of the total nitrogen should be in the form of nitrate. The potash may be supplied in the form of sulphate of potash, or a combination of sulphate and muriate of potash. While a portion of the potash may be supplied from water-soluble sources other than sulphate of potash, the chlorine content of the fertilizer should not be more than 2 per cent. It is recommended that a high-grade dolomitic limestone analyzing at least 19 per cent magnesia (MgO) be used in tobacco fertilizers, not as a filler, but as an ingredient to prevent magnesium deficiency and to supply a portion of the calcium required by the tobacco crop.

Fertilizer for the Seedbed

Use one bag of tobacco fertilizer containing 2 per cent nitrogen to 1000 square feet of bed, mixed with the muck before seeding. Under ordinary circumstances, when this application is made, no additional fertilizers are required in the seedbed.

Starter or Transplanting Solutions

Starter solutions used in the transplanter barrel have failed to improve the flue-cured tobacco crop in tests conducted over a period of years..

FLUE-CURED TOBACCO

Under normal condtions, 1000 to 1200 pounds per acre of 2-12-10 fertilizer furnishes the required amount of plant food. Where more than 1200 pounds is required for best quality and yield, a faulty cropping system is indicated.

A 2-12-10 fertilizer is recommended for present varieties grown under average conditions, and for heavier (finer-textured) flue-cured tobacco soils that have a fairly high, natural organic-nitrogen content. A 2-10-8 may be used to advantage on lighter (coarser-textured) soils where the potash content is at a more satisfactory level. A 3-10-8 may be used to obtain greater size of leaf on some of the light soils that have been intensively cropped to tobacco. However, the need for additional nitrogen indicates that the soil organic matter had been partially depleted, and this should be corrected.

Tobacco fertilizers of higher analysis are now being offered which are more economical than present standard analyses. They are recommended at proportionately lower rates of application per acre.

BURLEY TOBACCO

Burley tobacco responds readily to liberal supplies of active organic matter. Applications of farm manure, the use of crop residues, and the inclusion of soil-building crops are recommended. As burley tobacco soils in Ontario vary a great deal in type and fertility, a fertilizer should be chosen to suit the circumstances.

Under ordinary conditions, the additional plant food needed will be supplied by 500 to 1000 pounds per acre of commercial fertilizer. For sandy-loam and gravelly loam soils use 5-10-13. On these coarser-textured soils it will pay to apply half of the fertilizer two or three weeks after planting. On fertile dark-loam and clay-loam soils use 2-12-10 or 3-10-8.

DARK TOBACCO

The proper maintenance of soil organic matter is essential to provide suitable body, elasticity, and dark brown colour desirable in good quality wrapper leaf. In addition to manure or other organic matter, and under average conditions, apply 500 to 1000 pounds of 5-10-13 per acre. When heavy applications of farm manure are plowed under with alfalfa or sweet clover, a 3-10-8 may be found to mature the tobacco to better advantage, particularly on the finer-textured clay-loam soils.

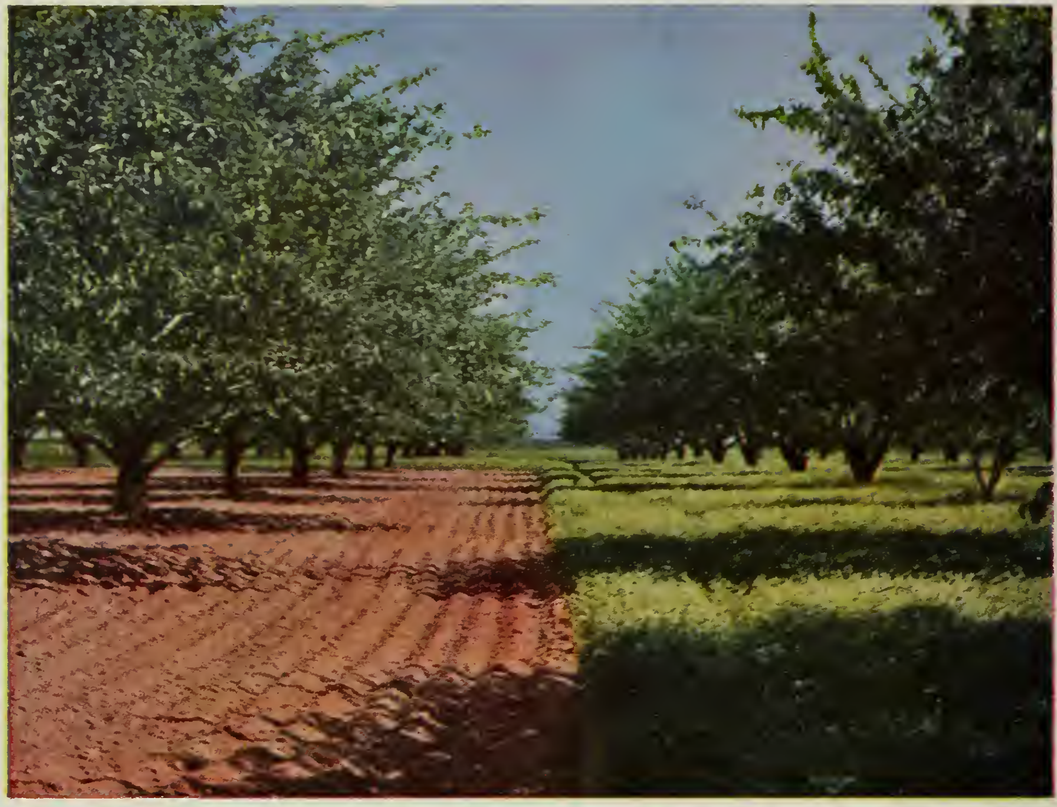

FIG 18. Cultivation "burns up" the organic matter in orchard soils. Reduce cultivation to the minimum needed for the kind of fruit crop, the soil type, and other conditions. Careful fertilizing will improve the green-manure crop, whether planted, or weeds.

FRUITS

You want bigger and better fruit crops. Partly, you can achieve these aims by better soil management, and better use of fertilizers.

The best information we have, much condensed, is in the next few pages. It is very much condensed in Table 8 on page 55, and that table may be sufficient for your needs. However, you will be better able to figure out the table recommendations if you also read these pages which tell you something of the why and the wherefore. You should read too, at least some of the items under Soil Management, pages 5 to 30. Particularly, read about soil aeration and drainage, organic matter, manures, tillage, and nutrient balance.

TREE FRUITS

First, study your trees and decide how well they are growing. The kind and amount of growth they are making is the best indication of fertilizer needs. You know when a tree looks "right". Pale foliage and short new growth indicate the need for more nitrogen. Too much nitrogen is indicated by excessive growth, deep-green foliage, poor fruit colour.

Sometimes, not often, there will be signs of mineral (potassium, phosphorus, magnesium, etc.) deficiency. Page 27 notes the symptoms.

Farm Manure

Use it carefully, especially in cultivated apple orchards. You should not apply it any later than *early* spring. The trouble is that the nitrogen in manure is released slowly, so your trees may grow too late, be subject to winter injury, and the fruit itself be of poor colour. You, as a grower, must decide to what extent you can safely use manure under your conditions of soil and climate.

Nitrogen

Probably your orchard requires nitrogen. Most bearing orchards do. But you must observe certain precautions. Your trees need generous amounts in the spring to start them into vigorous growth. But if there is too much nitrogen, or if it is applied late (or as in manure), fruit colour and quality may be poor. This is particularly true of apples, but it is true of other tree fruits as well, peaches included. So, avoid excessive nitrogen late in the season. As the fruit matures, a low-nitrogen condition in your soil will improve colour and quality, and help tree-wood to mature.

Nitrogen, for tree fruits, is best applied separately, rather than as part of a mixed fertilizer such as 5-10-13 (see page 52). Also, you won't find any definite nitrogen application rates in Table 8. And the rates given in the paragraph, Moderate Nitrogen Rates, are suggestive only.

Whether or not you should use any nitrogen, and the rate, depends on several things. How old are your trees? Are they cultivated or in sod? Is it a legume or a grass sod? Do you mulch under your trees? How well are your trees growing and fruiting now? Is fruit colour good, or fair only? And you should know how much phosphate and potash are in your soil. Extra nitrogen to a low-mineral-content soil will likely do more harm than good. A "balanced" food supply is needed. (See Nutrient Balance, page 25).

Fall and Spring Nitrogen Applications

Time of application is more important than the kind of nitrogen you use. You can apply ammonium sulphate and calcium cyanamide in late fall if you wish; but you should use nitrate of soda and ammonium nitrate as early spring applications, and as required during the growing season. If you use cyanamide in the spring apply it three weeks before you expect growth to start. For peaches and plums cyanamide is best applied in the fall. Cherries, sweet and sour, don't seem to like cyanamide at any time.

If you are an apple grower in eastern Ontario, you probably know that it is safer to apply all forms of nitrogen in the spring. Fall applications, unless carefully timed, may lead to winter injury in both sod and cultivated orchards.

Moderate Nitrogen Rates

Your best guides as to rates have already been suggested. However, as a starting point, and for cultivated orchards, the following rates may be considered as moderate, and of likely value in most orchards. Apply for each year of tree age: ammonium sulphate, 1/5 lb.; or cyanamide, 1/5 lb.; or ammonium nitrate, ⅛ lb.; or nitrate of soda, ¼ lb. Thus a 20-year-old tree would take 4 lb. ammonium sulphate or cyanamide, or 2½ lb. ammonium nitrate, or 5 lb. of nitrate of soda.

For sod orchards, unmulched, double the above amounts. If you mulch your sod, your need for nitrogen will vary with the kind of sod, legume or grass, and the mulch material you use.

Mineral Fertilizers

We have in mind phosphate and potash particularly. Tree growth or soil tests may show a shortage of one or the other. The rate of application will depend on the need, but fair applications per acre would be 400 pounds of superphosphate, and 200 pounds of potash. If both minerals are low, you may use 0-12-20 at 300 to 500 pounds per acre.

Minerals are of particular value in giving you a good growth of green-manure, whether weeds or a planted crop such as rye or clover. When this green material rots down plant food is released for your fruit trees. That is, if you feed the soil, the green-manure crop will get it first, but your fruit trees will get it later.

Complete Fertilizers

In the use of fertilizers your safest and most econimcal plan, as has been indicated, is to apply only what your soil and trees need. This may be nitrogen only, or phosphate only, or potash only, or some combination of these.

However, if you prefer a complete fertilizer, use 5-10-13, or a comparable analysis. If your orchard is growing and fruiting normally, the 5-10-13 should maintain it that way, partly by stimulating the growth of green-manure crops, or sod. Apply your complete fertilizer in late fall or early spring. If you delay until June or July, (cover-crop planting time) as you could do for a mineral-only fertilizer, the nitrogen will likely prolong tree growth and delay fruit maturity. That may mean winter injury.

A good application of 5-10-13 is 500 pounds per acre. If your orchard needs more nitrogen than this provides, it can be applied separately either as noted under "Moderate Nitrogen Rates", or as a foliar spray (see page 34).

Fertilizer Placement in Orchards

The simplest and least costly way is to broadcast, preferably with a fertilizer drill, but you may broadcast with a whirlwind seeder, or by hand. Surface-applied minerals, phosphate and potash, are lost in part by "fixation" (see page 17), but this is, perhaps, compensated for by the convenience and low cost of broadcasting as compared with deep placement.

In cultivated orchards broadcast minerals move down to the tree root-zone very slowly; also, fixation is much greater where the phosphate or potash is spread over large soil surface areas, as in broadcasting. Therefore, you should apply these materials when the soil can be worked immediately, or just before planting the green-manure crop. This crop will take up minerals and when it rots down later, the minerals will be released for fruit-tree use.

If your orchard is in sod, the fertilizer, whether complete or mineral only, is best broadcast in early spring. At that time the sod is coming into active growth, and rains wash the fertilizer down where the sod-crop roots can get it. There, as sod materials decompose, the fruit trees get their share of plant food.

The soil in your young orchard may be quite low in minerals. Deep placement with a subsoiler may be the best way for you to quickly step up the potash or the phosphate at tree-root depth. Where this has been done, young orchards have responded well. However, once the immedate need for minerals is satisfied, surface applications should take care of later needs.

Deep placement is expensive, as compared with broadcasting. It is justified where young trees show mineral starvation, and where hard pan or plow-sole conditions exist. Your trees are helped by the breaking up of the plow-sole. Drainage and aeration are improved, and the roots can go deeper where minerals are often in good supply.

As to subsoiling, three words of caution. (1) The subsoiler with its deep-placement attachment, does some root pruning. Therefore subsoil in late fall only, not in the spring. Also your subsoil is usually dry in the fall, and shatters to advantage as the subsoiler is pulled through it. (2) Use granular fertilizers only, as ordinary fertilizers will not flow freely through the machine. (3) Don't subsoil any closer to the tree trunks than just under the outer spread of the branches.

Sod and Sod Mulch

Mulching is something more than just mowing the sod crop two or three times during the season and letting the material lie where it falls. That's simply sod, not sod mulch. Also, even if you rake the cut material up under the trees, it may still fall short of a mulch.

For a proper mulch, enough to fairly well keep down grass and weed growth under the trees you will likely need to bring in extra material — old hay, straw, sawdust, etc. Spread it under the trees to a loose depth of 4 to 8 inches. Further, lighter, additions will be needed each year to maintain a good mulch.

The mulch makes quite a difference too, as shown in Table 8. If your orchard is in sod, but not mulched, it will need as much manure and fertilizer as a cultivated orchard. In fact, it will likely need more nitrogen, especially if it is a grass sod and not a legume one.

Also, if you are just starting to mulch your sod orchard, it may need the "cultivated-orchard" manure and fertilizer treatment for 3 or 4 years. It takes about that long for the undisturbed, mulched soil to get back to "normal", after years of cultivation and abuse.

GRAPES

Our Ontario grape soils are mostly heavy, and naturally fertile enough to produce fair to good crops of grapes. What they do need is organic matter, and it is here that manure and other organic matter, and commercial fertilizers have their value. Mineral fertilizers, as in orchards, increase the growth of green-manure crops, and these crops, rotted down, help to feed the grapevine. In a 19-year experiment*, added organic matter was the only soil treatment which gave a sufficient crop increase to pay for the materials applied.

* Horticultural Experiment Station, Vineland.

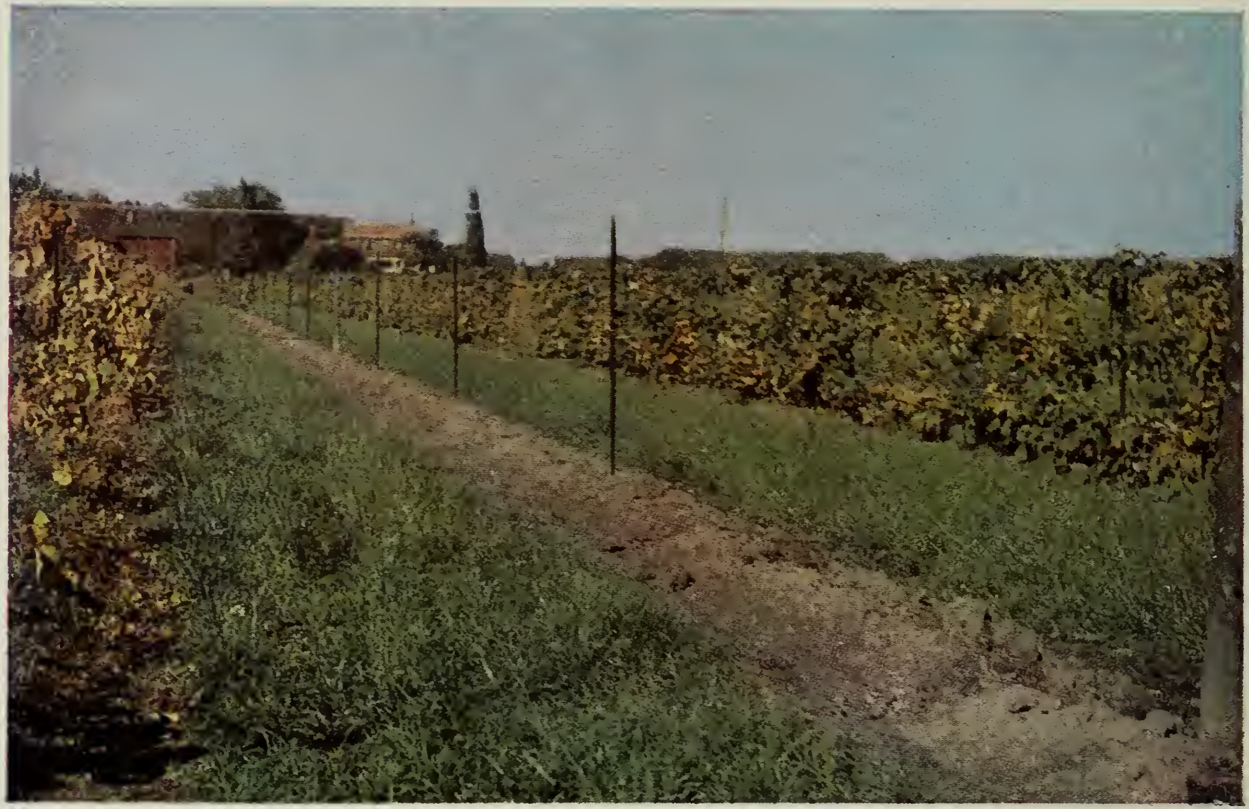

FIG. 19. Domestic (Italian) rye grass in a vineyard in mid-October. Soil texture is improved organic matter is added, erosion is reduced.

SMALL FRUITS

For small fruits your soil should be well supplied with organic matter. If it is, food and moisture will be there when the crops need it. And they need plenty and in a short period of time. Our small fruits are shallow-rooted crops, their season is short from bloom to harvest, and they produce a heavy weight of crop in proportion to plant size.

Currants and gooseberries thrive when mulched. In the hot summer days they like the cool, moist condition under the mulch. It takes a lot of mulch, however, as one grower testifies. He says, — "Mulching gooseberries requires at least 50 large truck-loads of alfalfa threshings per acre annually to maintain a 4-inch mulch. Less will not keep down the weeds".

Raspberries are grown mostly on the coarser, lighter soils, and these are often low in potash. Hence they are likely to respond to potash applications.

Strawberries prefer newly broken soils, that is, soils which have been out of cultivation for some years. Such soils are in good physical condtion, and there will be lots of organic matter when the sod is plowed down. If you haven't such a soil and must use an old one, you should give it considerable preparation. Plan to build up the organic matter and, at the same time, get control of the weeds. This may be done by heavy manuring a year in advance of strawberry planting, and then growing a well-fertilized, weed-smothering green-manure crop.

If your soil is somewhat acid, that doesn't matter. Strawberries like it that way, or at least will tolerate it, but they don't like alkaline soils. So, when applying fertilizers, if possible use those which, like ammonium sulphate, tend to give an acid reaction. Ammonium sulphate has its limitations too, as it may burn the foliage if carelessly applied when renewing an old patch.

Table 8. RECOMMENDATIONS FOR FRUIT CROPS

NOTE—"N"=Ammonium Nitrate or Equivalent. "GM"=Green Manure.

	Manure, Hay, Straw (See Footnote †)	Fertilizers	Nitrogen	Soil Management
ORCHARDS, CULTIVATED AND UN-MULCHED SOD (see Text)	Either 10 tons manure annually in the fall. Or 3 tons hay or straw* annually in fall with 75 lb. N. Add another 75 lb. N. in the spring.	200 Superphosphate and 125 Potash or 300 0-12-20 With G.M. crop or on sod (5-10-13, see Text)	In late fall, or spring, am't based on tree age, (see Text-'NITROGEN')	If Cultivated stop before June 15. Plant a G. M. crop. If Sod Mow as required.
ORCHARDS, SOD MULCH	No manure needed where a proper mulch is maintained. Mulch under trees with cover grown and cut in orchard, with additional old hay, straw, etc., as needed.	Apply mineral fertilizers, if needed, and in amounts indicated by soil tests.	As needed. In late fall, or spring, am't based on tree age, (see Text)	Mow as required and place material under trees.
GRAPE	Either 10 tons manure at least every other year. Or 3 tons hay or straw* in fall at least every other year with 75 lb. N. and 250 lb. 0-12-20. Trash disk. Add 75 lb. N. in the spring.	250 0-12-20 annually with G.M. crop.	Only as a supplement to non-legume hay or straw.	Stop cultivation about June 15, and plant a G.M. crop.
STRAWBERRY	Year previous to planting. Either 20 tons manure in spring. Or 6 tons hay or straw* in spring with 150 lb. N. Add another 150 lb. N. in the fall.	Year previous to planting 400 Superphosphate and 200 Potash or 600 0-12-20 With G.M. crop	After planting. Side dress with 75 lb. N. after plants have become well established.‡	Season previous to planting. Grow a G.M. crop.
RASPBERRY	Year previous to planting. Either 20 tons manure in spring. Or 6 tons hay or straw* in spring with 150 lb. N. Add another 150 lb. N. in the fall.	Year previous to planting 400 Superphosphate and 200 Potash or 600 0-12-20 With G.M. crop	Only as a supplement to non-legume hay or straw.	Season previous to planting. Grow a G.M. crop.
	After planting. Either 10 tons manure annually or 3 tons hay or straw* annually in fall with 75 lb. N. Add another 75 lb. N. in the spring.	500 - 700, 5-10-13	Only as a supplement to non-legume hay or straw.	Each year after fruiting time, plant a G.M. Crop
CURRANT and GOOSEBERRY	Either 10 tons manure annually. Or 3 tons hay or straw* annually in fall with 75 lb. N. Add another 75 lb. N. in the spring.	500 - 700, 5-10-13	Only as a supplement to non-legume hay or straw.	Each year after fruiting time, plant a G.M. Crop
	As a complete alternative to the above for currants and gooseberries, maintain a legume mulch over the entire plantation. Use such materials as alfalfa threshings.	No nitrogen* supplement is necessary. Maintain at 4 to 6 inch depth by annual additions. While expensive, this method has been demonstrated to be commercially feasible.		

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* If legume materials are used the nitrogen supplement is unnecessary.

‡ Repeat after fruiting if patch is to be fruited a second year.

† Manure, Hay, Straw, Green-manure crops or weed growth may supply sufficient organic matter, especially if well fertilized. However, most orchards will need some manure, or hay or straw.

VEGETABLES

High production, improved quality of product, and maintenance of soil fertility are the primary aims of the vegetable grower. The importance of higher-quality vegetables is increasingly recognized inasmuch as the health and vigour of the population is influenced by mineral and vitamin content.

Unless soils are in good physical condition, plants cannot make satisfactory growth, nor will added fertilizers give their best response. Growers are advised to read carefully Soil Management, pages 5 to 30, on drainage, organic matter, manure, and cultivation.

In this Vegetable section there are recommendations for three crop groups:

1. Market Garden Crops on Mineral or Upland Soils.
2. Market Garden Crops on Organic Soils (muck and peat).
3. Canning Crops.

Before dealing with the specific recommendations for the above three crop groups, let us consider several problems of soil management which have fairly general application.

Drainage

Good drainage is of vital importance to high production. Surface drainage in most cases is not enough. See page 5, Air and Water.

Organic Matter

The text on page 7 deals with the importance of organic matter for all farm crops. The intensive cultivation given vegetable land oxidizes or burns out the organic matter very rapidly, and where irrigation is practised there is a further loss of organic matter. Green-manure crops and cover crops should be used whenever the land is idle for any length of time.

Liming

Attention is often drawn to soil reaction, or pH (see page 22) without stressing that the calcium (lime) used to correct excess acidity is also one of the essential plant foods . (See page 23, The Major Elements). Dolomitic limestone which contains magnesium, is preferred for soil that is low in magnesium. Lime may be applied at any time during the spring, summer, or fall. It is best broadcast and worked into the topsoil by harrowing, or by disking and harrowing.

Trace Elements

Trace or minor elements should be applied only on competent advice or where experience has proven their application to be necessary. Boron, copper, magnesium and manganese are discussed below. For other, and more general information on trace elements see page 23.

Boron. A lack of boron may cause "cat-scratches" on celery; cracking or drought-spot of root crops; internal breakdown of beets, cauliflower and turnips. As boron is needed in only very small quantities, and since an over-dose will prove toxic, extreme care should be taken in its use. Continued application should not be made unless on expert advice. Application of boron to mineral soils has not been universally successful, but foliar sprays have generally given faster and more effective results. Apply 3 to 4 pounds of borax in 100 gallons of water and spray when the young plants are about three inches high. Follow this application with a second where the need is known.

Copper. A lack of copper may cause "rabbit-ear" in lettuce; poor colour and keeping quality in onions; poor quality in carrots. As in the case of boron this element must be used with care.

Magnesium. A magnesium deficiency is indicated in some of the older soils on such crops as carrots, celery and spinach. The usual symptom is yellowing of the foliage while the veins remain dark green, and is more evident on the lower leaves. Control may be obtained by the application of 3 pounds of magnesium sulphate in 100 gallons of water when the plants are about one-third grown, or sooner if the plants show yellowing. Follow with further applications where necessary. When practicable, these special foliar sprays may be included in the regular crop sprays.

Manganese. There has been some evidence of manganese deficiency in some crops. The general symptoms are rosetting of beets, and a certain type of yellowing on carrots and onions. There are some indications of this deficiency in tomatoes. Spray applications of 4 pounds of manganese sulphate to 100 gallons of water have proven more effective than direct soil applications. Apply when the plants are about one-third grown, or sooner if the plants show yellowing. Two or more sprays may be necessary at ten-day intervals to correct the deficiency.

The Importance of Soil Testing

Correct balance of fertility is very impotrant in commercial vegetable growing. The very intensive cultivation program necessary for continuous high yields calls for a thorough understanding of how to maintain organic matter and nutrient levels. (See page 23, The Nutrient Elements; and page 29, Soil Testing.)

Transplanting and Booster Solutions

Fertilizer solutions have proved of value when applied to the seedlings in the flats 3 to 4 days before transplanting, at transplanting time, and as a booster some time after transplanting, or in case of a check from drouth or other causes. (See page 33, Fertilizers in Solution).

Green-manure Crops

After harvesting the *early* vegetable crop, plant a green-manure crop. The following crops are suggested, varying with conditions. Generally the rate recommended is a minimum one.

1. Winter rye at 2 bu., or rye and oats at 1½ bu. each.
2. Domestic or Italian rye grass at 20 lb. per acre.

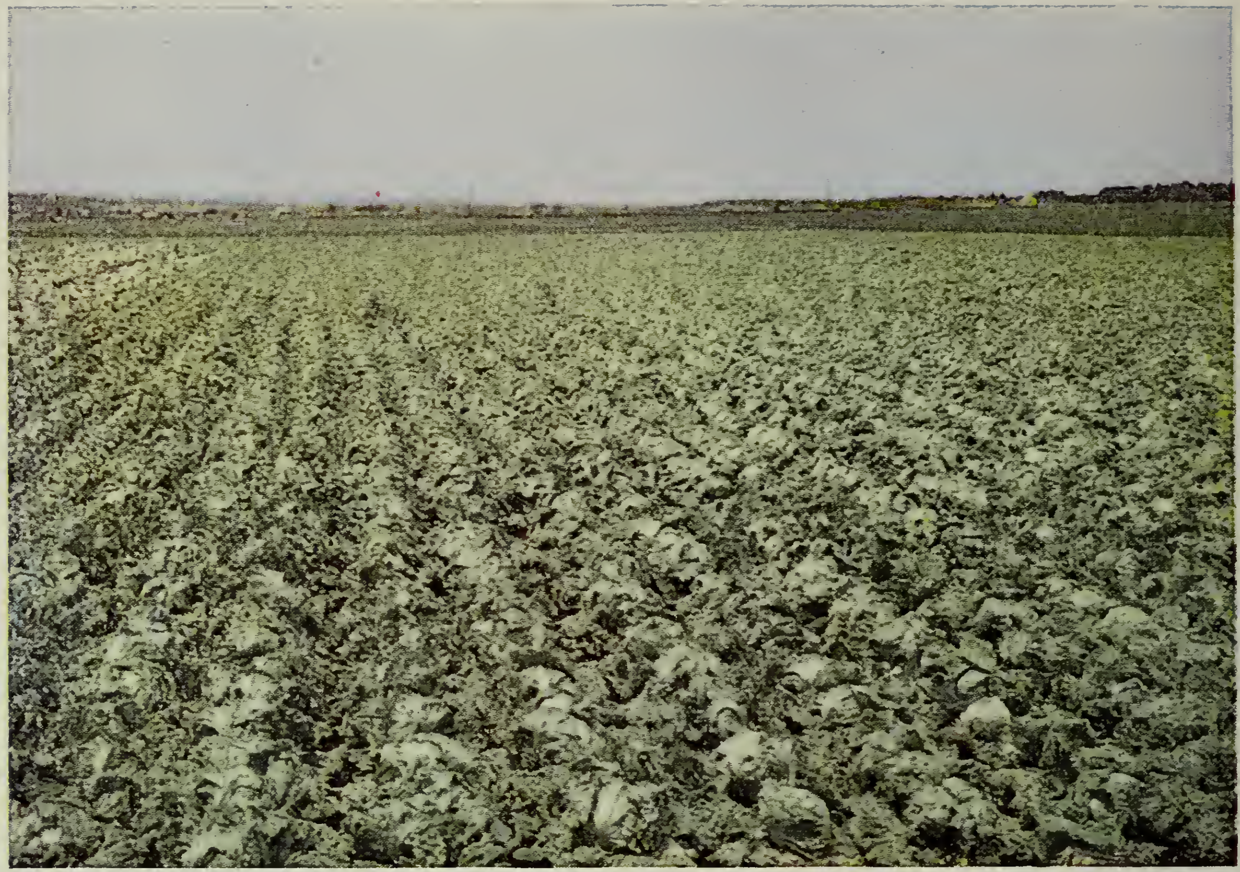


Fig. 20. Bradford Marsh lettuce. The organic soils of Ontario vary greatly in their composition. Mineral fertilizers usually are necessary, but should be used as to analyses and amounts as the need is shown by careful, repeated, soil tests.

3. Soybeans at 2 bu. per acre, inoculated with a suitable culture and treated with Spergon or Arasan seed disinfectant.
4. A soil difficult to work is better taken out of cultivation for a year and planted to sweet clover at 30 lb. per acre.
5. Where irrigation is available, or there is an abundance of soil moisture, Sudan grass may be sown at 30 lb. per acre.
6. When no early vegetable crop is planted use a green-manure crop. A mixture of peas (1 bu.) and oats (2½ bu.) is recommended. Sow this mixture as early as possible in the spring

Whenever a green-manure crop is used and no subsequent winter cover-crop planted, it is best to let the green-manure crop stand over winter. Before trash-disking (see page 15) and plowing in the spring (at least two weeks before planting) broadcast the fertilizer planned for the vegetable crop.

Cover Crops

Following the *late* vegetable crops, an over-wintering cover-crop should be sown. The most effective crops for this purpose are:—

1. Winter rye at 3 bu. per acre.
2. Domestic or Italian rye grass at 20 lb. per acre.
3. If a small-seeded spring vegetable crop is contemplated do not use rye, as the heavy straw will make seeding difficult. Instead, plant either spring wheat or oats at 2 bu. per acre. These crops will be killed by the frost and will not cause any difficulty in seeding next spring.

MARKET GARDEN CROPS ON MINERAL OR UPLAND SOILS

The soils preferred are of the lighter types (sandy loams and silt loams), must be well drained, and should receive annual applications of organic matter and fertilizer to maintain high production. There will be occasions when the land is to remain idle for a short period of 4 to 6 weeks. Rather than leave this land bare, seed a green-manure crop, turning under when it is time to sow the next vegetable crop. Where this may not be feasible owing to rapid succession crops, *large amounts of manure must be applied,* a minimum of 20 tons per acre. A periodic check of fertility levels should be maintained by soil tests.

TABLE 9. GENERAL RECOMMENDATIONS FOR MARKET GARDEN CROPS (1) ON MINERAL OR UPLAND SOILS

Crop	Rate per Acre in Pounds, and Fertilizer Analysis Coarse-textured or Light Soils	 Fine-textured or Heavy Soils
Asparagus (2)	1600 – 5-10-13	1200 – 5-10-13
Beans (3) (8)	500 – 4-12-6	500 – 4-12-6
Beets	1000 – 4-12-6	750 – 4-12-6
Cabbage (4)	800 – 5-10-13	600 – 5-10-13
Carrots	1000 – 4-12-6	1000 – 4-12-6
Cauliflower (4)	800 – 5-10-13	800 – 5-10-13
Celery (4)	1000 – 5-10-13	1000 – 5-10-13
Chard	800 – 5-10-13	800 – 5-10-13
Corn, Sweet (8)	600 – 4-12-6	600 – 4-12-6
Cucumbers	800 – 5-10-13	800 – 5-10-13
Early Potatoes	1200 – 4-12-6	1200 – 4-12-6
Late Potatoes	1200 – 5-10-13	1000 – 5-10-13
Lettuce	800 – 5-10-13	600 – 5-10-13
Melons	800 – 5-10-13	800 – 5-10-13
Onions (5)	800 – 5-10-13	800 – 5-10-13
Parsnips	800 – 5-10-13	600 – 5-10-13
Pumpkins	1000 – 4-12-6	1000 – 4-12-6
Spinach (6)	800 – 5-10-13	800 – 5-10-13
Squash	1000 – 4-12-6	1000 – 4-12-6
Eggplant	1000 – 5-10-13	1000 – 5-10-13
Peas (3) (8)	500 – 2-12-10	500 – 2-12-10
Peppers	1000 – 2-12-10	1000 – 2-12-10
Tomatoes (7) (8)	1000 – 2-12-10	1000 – 2-12-10

Note:—The special needs of individual crops are discussed under reference numbers as indicated.

1. *These recommendations are general only.* Supplementary side-dressings of nitrogen and potash may be applied as required. (See page 33, Side Dressing). Where higher analyses fertilizers of the same ratio can be secured their use is recommended, at proportionately lower rates.

2. *Asparagus.* A good start is given the new bed by sowing 1500 pounds of 2-12-10 per acre in the bottom of the trenches before planting. Cover the fertilizer with some soil before setting the plants. Cyanamide in the granular form may be used to control broad-leaved annual weeds in the established planting when the weeds are not more than one inch high. Apply at the rate of 200 to 300 pounds per acre, in a band of the required width, directly over the row, soon after cutting begins. If preferred, a broadcast application of 400 pounds per acre may be made. A later application of 100 pounds per acre of pulverized cyanamide during the cutting season, and another at the same rate when the cutting season is over and the asparagus is about 18 inches

high, will give good control of weeds. Apply on a still morning when the dew is present, and there is prospect that a bright, hot day will follow. The use of a duster will facilitate light, even applications.

3. *Beans, peas.* Do not sow fertilizer in direct contact with these seeds as injury may result.

4. *Cabbage, cauliflower, celery.* These crops respond to side-dressings of nitrogen and potash supplementary to the regular fertilizer application. Where crop experience has shown, or the need for boron is clear, particularly on celery, apply borax. (See page 23, Trace Elements).

5. *Onions.* Side-dress with nitrogen or potash as required.

6. *Spinach.* Side-dress with nitrogen to maintain rapid, continuous growth.

7. *Staked and early tomatoes.* Side-dress where necessary with 200 pounds of ammonium nitrate and 400 pounds of muriate of potash about the time the staked varieties have set the third cluster of blossoms.

8. *Where tomatoes, corn, peas, and beans* are grown for canning purposes see specific recommendations under Canning Crops, page 62.

MARKET GARDEN CROPS ON ORGANIC SOILS (MUCK AND PEAT)

Virgin organic soils are normally deficient in phosphate and potash, and their calcium content varies. The total nitrogen contained in organic soils is high but in most instances is not readily available to plants in the spring until the soil becomes warm. In general the nitrogen in fertilizer is added to promote growth before the nitrogen in the soil becomes available.

Organic soils vary so greatly in their composition and fertilizer needs that each should receive individual treatment based on experience, experimental evidence, and soil tests. Soil tests are useful to determine deficiences or excesses of plant nutrients. (It is especially important to avoid such extremes owing to low mineral content of these soils). As there is relatively little penetration of organic soils by summer rains, fertilizers should be placed 3 to 5 inches below the surface, either by grain-drill application or by disking.

There is experimental evidence to show that fertilizer requirements differ for various organic-soil areas. Table 10 contains *general* recommendations for crops on organic soils of Ontario. Note the varying recommendations for the three soil types — Normal Muck, Alkaline Muck, and Peat and Acid Muck.

It would be well for all growers, on all muck soils, after having used the recommendations in Table 10 for a period of five years, to have their soil analysed to ensure that excess residues of certain of the minerals are not building up to an unbalanced condition.

Side-dressing with nitrogen and potash is recommended where the need is indicated by growth symptoms.

For newly broken organic soil the maximum of fertilizer application indicated in Table 10 should be made for one year at least. Also, extra potash may be required for celery for two or three years. As the soil becomes activated by the addition of fertilizer and by cultivation, lower rates are usually sufficient.

TABLE 10. GENERAL RECOMMENDATIONS FOR VEGETABLES ON ORGANIC SOILS

Crop	Rate per Acre lb.	Normal Muck pH 5 to 7 †	Alkaline Muck pH 7.1 to 8.5	Peat and Acid Muck pH below 5
Beet	500 – 1000	2-8-16	2-12-20	3-12-16
Cabbage	600 – 1000	2-8-16	2-12-20	2-8-16
Carrots	800 – 1500	2-8-16	2-12-20	5-10-13
Cauliflower	800 – 1200	2-8-16	2-12-20	5-10-13
Celery	1200 – 1500	2-8-16	2-12-20	
Cucurbits	500 – 1000	3-12-16	2-12-20	5-10-13
Lettuce	600 – 1000	2-8-16	2-12-20	3-12-16
Onion	1000 – 1500	2-12-16	2-12-20	3-12-16
Parsnip	1000 – 1200	2-8-16	2-12-20	3-12-16
Potato	1000 – 1500	2-8-16		3-12-16
Radish	500 – 1000	2-8-16	2-8-16	5-10-13
Spinach	600 – 1000	2-8-16	3-12-16	3-12-16

† Recent experimental evidence indicates that, for all crops grown in the Holland-Bradford marshes, with the exception of onions, the fertilizer should contain four per cent more phosphate than shown for Normal Muck in Table 10. Also, for the leafy crops, the fertilizer should contain one per cent more nitrogen than shown for Normal Muck.

There are shallow organic soils that have been in cultivation for a relatively long time, and the organic material is now less than a foot in depth. On such soils, more nitrogen and less potash is needed than shown in Table 10. The grower can use either a suitable complete fertilizer such as 3-12-6 or 5-10-13, or a lower potash fertilizer such as 2-12-10, and supplement with additional nitrogen.

Trace Elements for Organic-soil Crops

(See also page 23, Trace Elements).

Boron. Where boron deficiency is known to exist, a soil application of borax at 15 to 20 pounds per acre will usually correct the deficiency for most crops. Borax may also be applied as a foliar spray. Use 4 pounds borax in 100 gallons water, applying this amount per acre, spraying the plants when they are 3 to 4 inches high. If needed, a later, second application may be made.

Copper. Where copper is not used as a fungicide, (as in Bordeaux mixtures or fixed copper compounds) the application of 40 to 50 pounds per acre of copper sulphate will correct ordinary deficiencies. The carrot, onion, and spinach crops require such applications annually.

Magnesium. On organic soils, symptoms of magnesium deficiency are common with such crops as celery, spinach and carrots. The usual symptom, most evident on the older, lower leaves, is a yellowing of the foliage, while the veins remain dark green.

For control use magnesium sulphate, 3 pounds in 100 gallons water, and spray when the plants are about one-third grown, or sooner if there is foliage yellowing. Weekly applications should be made thereafter until one week before harvest. When practicable, these special foliar sprays may be included in the regular crop sprays for pest control.

Manganese deficiency is fairly common on organic soils. It may be corrected by : (1) Manganese sulphate applications, 50 to 100 pounds per acre. (2) Spraying the foliage with 8 to 10 pounds of manganese sulphate in 100 to 150 gallons of water, using this amount per acre.

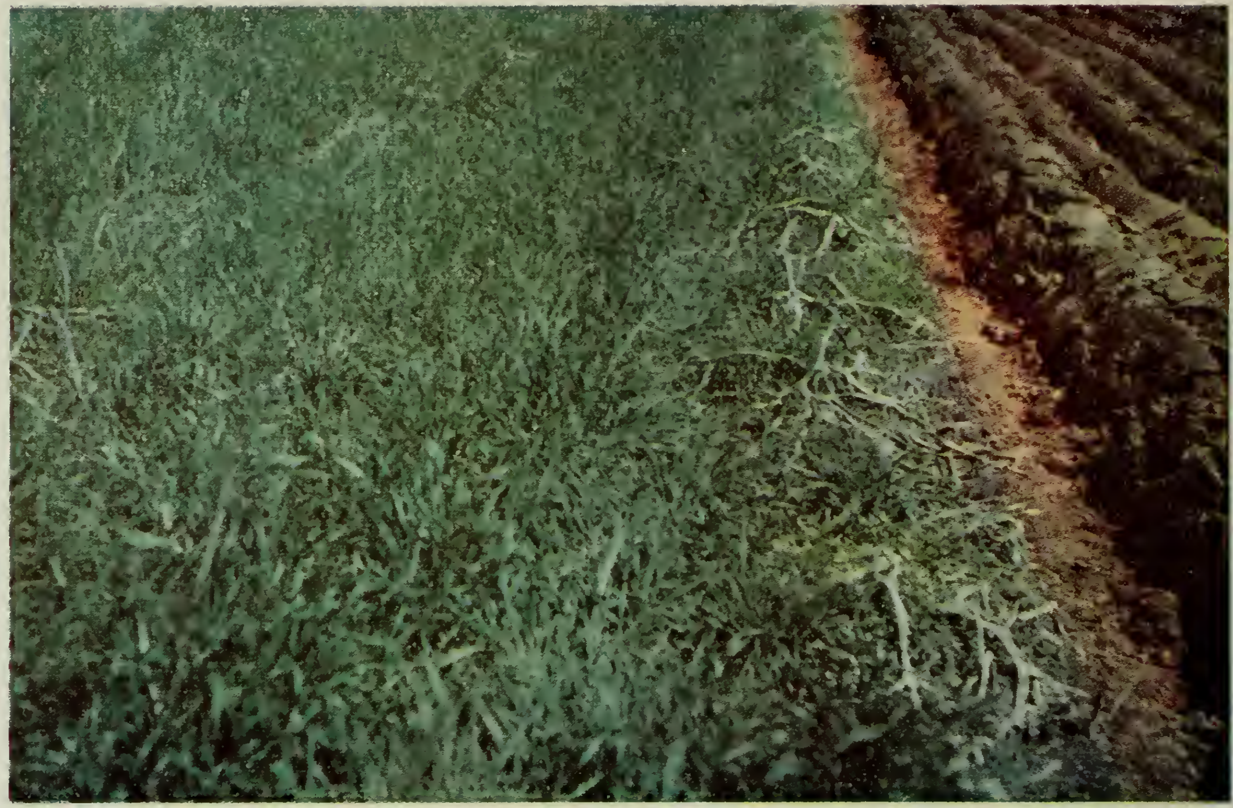


FIG. 21. On the lighter soils, rye grass, sown in tomato crops at the time of the last cultivation, will protect the soil over winter, utilize and hold available soil nutrients, and contribute organic matter. Note that, at the time of spring plowing, tomato vines and skins are almost hidden by lush growth.

CANNING CROPS

Readers are urged first to become familiar with the information in the section Soil Management, pages 5 to 30.

Crop Rotations

When canning crops are grown as cash crops on general farms, soil fertility may be maintained by growing them in a suitable rotation, supplemented with farm manure and commercial fertilizers. The importance of legumes and grasses in the rotation cannot be too strongly emphasized since they maintain porosity and good soil structure in the heavier fine-textured soils, and improve their moisture-holding capacity. Hay or pasture, or grass-legume green-manure crops should be included in the rotation at least once in three years or, better still, twice in every four or five years if yield and quality of the canning crops are to be maintained or improved.

When canning crops are grown on more specialized cash-crop farms, carrying little if any livestock, the maintenance of soil fertility is a more difficult problem. If it is necessary to employ shorter rotations maximum use should be made of green-manure crops, after harvesting an early maturing canning crop such as peas. Even after later-maturing crops it is often possible to seed a winter cover such as a fall-sown cereal. In some cases dry organic-matter supplements, such as old hay and straw, may be used. (See page 9).

Manure

Manure may be spread during the winter or early spring, but for best results apply just prior to plowing down the sod. Generally, when sod land is plowed in late summer or early fall it should not be left bare over winter. A fertilized cover-crop sown at this time will utilize and hold nutrients, reduce soil erosion, and contribute organic matter.

Soils for Canning Crops

Proper management of the soil and maintenance of the fertility level are more important than soil type. Crop rotation and fertilizer practices for sandy soils will naturally differ from those for clay soils. If soil management is given the right attention, the various canning crops can be grown on most soil types provided the climate is suitable and the drainage is good. The subject of soil management is fully covered in the forepart of this bulletin. Growers of peas and beans should select fields that are relatively uniform to promote even crop maturity.

Beans, Snap

Apply 400 to 600 pounds of 5-10-13 per acre *either* in bands 2 inches on either side of the seed and about 3 inches deep, *or* apply the fertilizer as deeply as possible with a grain-fertilizer drill.

Beans, Lima

Apply 400 to 600 pounds of 4-12-6 per acre in the same manner as for snap beans.

Beans, Field

Fertilization of this crop is discussed on page 43 under Intertilled Crops.

Corn, Sweet

Apply 400 to 600 pounds of 5-10-13 or 4-12-10 per acre. Apply with a grain-fertilizer drill allowing all tubes to sow fertilizer. Where growers use corn planters with fertilizer attachments approximately one-quarter of the above application should be retained for use through the planter attachment.

Side-dress when the sweet corn is about 12 to 18 inches high. Use 150 pounds of ammonium nitrate on clay soils; on the lighter soils use 150 pounds of ammonium nitrate and 50 pounds of potash per acre.

Peas

To avoid injury to the seed it is recommended that the fertilizer be applied a few days previous to planting. Use 300 to 500 pounds of 2-12-10 per acre.

Where additional nitrogen is required, use either 150 pounds of ammonium nitrate or 240 pounds of cyanamide. When annual weeds are present cyanamide is preferred to ammonium nitrate as cyanamide gives satisfactory pre-emergence weed control.

FIG. 22. Well-kept farm-home surroundings reflect farming made successful by good soil-management and fertilizer-use.

Tomatoes

When setting out tomato plants use a transplanting solution (see page 33, Fertilizers in Solution).

Broadcast 1000 pounds of 2-12-10 per acre and disk into the soil before planting; or on the heavier soils sow two-thirds to three-quarters of the 1000 pounds with the grain fertilizer drill, and the remainder in bands on each side of the plants. Nitrogen analyses higher than 2 per cent are not recommended.

To prevent fall starvation and to insure proper ripening of the crop, side-dress at the time of the last cultivation with approximately 100 pounds per acre of muriate of potash. An additional application of 100 pounds ammonium nitrate per acre may be applied at the same time, where poor growth or excessive rainfall indicate a need.

Other canning crops such as asparagus, cucumbers, beets, carrots, spinach, cabbage, etc., are considered under recommendations for Market Garden Crops.

TURF AND LAWN

The value of good turf is measured not in dollars, but in terms of health, well-being, and pleasure from the relaxation and recreation provided by home lawns, golf courses, bowling greens, playgrounds, and parks.

The basic principles of turf establishment and management apply to all turfs. Procedures are determined by local soil and climatic conditions, and by the use to which the turf is put.

Types of Turf

Group 1. Fine (putting and bowling greens)

Group 2. Medium (lawns, fairways, parks)

Group 3. Coarse (playgrounds, roadsides, airfields)

The actual group classification will depend on such factors as the species of grass used, the height of cutting, and general management. Generally speaking, the bent grasses are used for Group 1 or Fine turf; the blue grasses and fescues form the basis of mixtures for Group 2 or Medium turf; and the blue grasses and fescues, with or without coarser species, are used for Group 3 or Coarse turf.

Establishment of Turf

In order to establish good turf the soil must be in good physical condition, well drained, and supplied with adequate quantities of humus and nutrients. The selection of the species of grass will depend on the type of turf desired, and on local soil and climatic conditions. Prior to seeding, care should be taken to supply ample plant food. This can be done by applying a complete fertilizer such as 4-12-6, 4-12-10, or 5-10-13, at 20 to 40 pounds per 1000 square feet of lawn surface.

Maintenance

Maintenance of a good turf depends on proper cutting, fertilization, watering, and aerating, as well as disease, insect, and weed control.

Cutting. The correct height to cut grass is important. Group 1 or Fine turf should be cut to a height of ⅛ to $\frac{5}{16}$ of an inch, Group 2 or Medium turf to a height of 1½ to 2 inches. The height of Group 3 or Coarse turf will depend on the quality of turf desired.

Fertilizing. For Group 1 or Fine turf where the clippings are removed, heavy fertilization is necessary. In early spring and again in early fall apply, per 1000 square feet of lawn, from 8 to 10 pounds of a 10-6-4, or other high-nitrogen complete fertilizer; and in the interval, monthly applications of nitrogen are desirable. For group 2 or Medium turf make spring and early fall applications of a high-nitrogen complete fertilizer at 8 to 10 pounds per 1000 square feet of turf with additional applications of nitrogen if necessary. For Group 3 or Coarse turf apply a complete fertilizer as required to maintain a good stand of the quality desired. Fertilizer should be applied uniformly, when the grass is dry, and, where possible, watered-in immediately to avoid burning. It is desirable that some of the nitrogen applied be in a slowly available organic form.

Watering. Watering, if done, should be thorough so as to moisten the soil to a depth of at least four inches. Avoid frequent sprinklings which encourage shallow rooting.

Aeration. If the soil becomes compacted it must be loosened to permit proper growth of the grass roots. Golf and bowling greens are more subject to compaction than lawns, fairways, or playing fields. Machines known as "aerifiers" can be used for large areas, and tubular forks or hand-operated "aerifiers" for small ones.

Diseases and insects. Consult Ontario bulletin ℵ448, Lawns; or, "The Construction and Care of Lawns", which may be secured from the Central Experimental Farm, Ottawa, Canada.

Weeds. Judicious fertilization and good management will do much to control many weeds. Herbicides, used as sprays or dusts, are now available and will control most weeds. After chemical treatment for weeds use fertilizer and, if necessary to re-establish the turf in bare, weed-destroyed areas, top dress and re-seed.

FERTILIZING FISHING WATERS

In Canada and the United States there is an increasing interest in the fertilizing of fishing waters to promote larger size of game fish, and larger populations. It is, in fact, emerging as an interesting and lucrative practice, paralleling other efforts to conserve and improve natural resources of farm and forest.

Microscopic plant and animal organisms, termed plankton, provide the basic food supply of water life, and thus eventually for game fish. Research has shown that the supply of plankton is enormously increased where it is fed by applications of commercial fertilizers.

There are two general types of game-fish waters, farm ponds, and trout ponds and lakes.

Farm Ponds

These are generally still, shallow bodies of water which may or may not have a running inlet. Such ponds are becoming quite numerous, as part of farm conservation schemes. Fish production is restricted to such species as large-mouth black bass and bluegill sunfish.

Various fertilizers may be used, including 10-6-4, 5-10-13 and 4-12-6. As to rate, a general recommendation is 1000 pounds per "acre", but applied in 80- to 100-pound lots at intervals of two or three weeks, to maintain a rather dense phyto-plankton bloom throughout the season.

Trout Ponds and Lakes

To support trout populations these bodies of water must be of the deeper, colder type, with a fast-moving water supply. Most of the Canadian work in fertilizing waters, in Northern Ontario and Quebec, has been done with this type. Results have been encouraging, using 5-10-13, 4-12-6 and, more often, 12-24-12. A general recommendation is to use 20 pounds of 12-24-12 per acre-foot of water per year, in three equal applications about three weeks apart, in the period from late May to August.

Care should be taken not to over-fertilize. Over-stimulation of plankton growth will draw too heavily on the water's oxygen supply, and thus adversely affect fish life. This oxygen problem applies chiefly to lakes with a low change-over in water supply, and to conditions where there is heavy, winter formation of ice. Usually it is not a serious problem with farm ponds, where there is frequent change of water from rain and melting snow.

REFERENCES

Cir. 4 Farm Drainage.
Bul. 425 Legumes for Profit.
Bul. 448 Lawns.
Bul. 457 Orchard Soil Management.
Bul. 459 Organic Matter.
Bul. 469 Better Ontario Pastures.
Bul. 477 Does Your Soil Need Lime?
Bul. 492 Ontario Soils, Their Use, Management and Improvement.
Pub. 703 Tobacco Soils and Fertilizers.
Pub. 853 Organic Soil Management for Vegetables.

Circular 4 and the bulletins may be secured from the Department of Agriculture, Parliament Buildings, Toronto.

For publications 703 and 853 write to the Publicity and Extension Division, Department of Agriculture, Ottawa.

BULLETIN 498 OCTOBER 1953

RATS AND MICE

ONTARIO AGRICULTURAL COLLEGE
GUELPH, ONTARIO

I'LL COST YOU TWENTY DOLLARS A YEAR FOR MY KEEP!

ONTARIO DEPARTMENT OF AGRICULTURE
PARLIAMENT BUILDINGS, TORONTO, CANADA

RATS AND MICE

by

REG. H. OZBURN, Professor
Department of Entomology and Zoology
Ontario Agricultural College
Guelph, Ontario

(A) INTRODUCTION

Rats and mice are the most destructive mammalian pests with which urban or rural dwellers in Canada have to contend. They gnaw their way into homes and buildings. They feed on almost any human food material. The farmer has his granary and feed bins raided, his stable walls undermined, his poultry killed, and his fruit and vegetables damaged or destroyed. Hundreds of tons of grain and other foodstuffs are eaten or polluted by rats and mice each year. The extent of these preventable losses is difficult to determine. Conservative estimates of the annual loss caused by these rodents in Canada runs into millions of dollars.

It has been repeatedly estimated that it costs at least five dollars per year to feed a rat and that, including food spoilage and damage caused by the rat, the total cost of tolerating one rat for a year is somewhere around twenty dollars.

Not only do rats and mice eat and spoil large quantities of food and damage buildings, but they also damage clothing, house furnishings, furniture, and other goods, both inside and outside of buildings. They are a menace to human health. They have filthy habits. They frequent garbage, manure piles, sewers and other accumulations of refuse and filth, and, like the ubiquitous house-fly, go from such places into homes, restaurants, mills or other buildings, contaminating and polluting food, utensils, clothing, etc. Their hairy bodies, their feet and their dragging tails are admirably suited to disseminate disease germs. They serve as reservoirs for diseases which can be spread to humans and other animals by their filthy habits, by their droppings, and by their parasites. Parasites such as fleas, sometimes forsake living rats, and will leave dead rats, for other animals. Such diseases of humans as bubonic plague, tularemia, murine typhus, rat typhoid, trichinosis, rat-bite fever and mange, are spread by rats or their parasites. Anthrax, fowl cholera, fowl tuberculosis, hog cholera and swine erysipelas may also be spread by rats.

REPRODUCTION

Rats and mice are amongst the most prolific of animals. If food and shelter are available they may have from three to several litters of young per year. (12–15 litters per year are possible). A litter may consist of 2 to 12 or more young. Norway rats have had as high as 17 in a litter. The gestation period is approximately 21 days. Females may breed at as early an age as 50 days for mice and 100 days for rats. Females often breed when apparently half-grown.

Fortunately breeding is restricted to some extent by our Canadian winters. In spite of this, under favourable conditions, the progeny of one pair of rats may exceed 500 individuals in a year if all the young, particularly females, survive and breed. One laboratory experiment, which began with one pair of rats, resulted in more than 1,500 rats by the end of the year.

Signs of the Presence of Rats and Mice

On many premises rats and mice may be seldom seen; they prefer to remain unobserved. Their presence can usually be detected by:

(a) The sounds they make when scampering about, or by their squeaking.
(b) Their droppings which are blackish, somewhat soft and shiny when fresh, becoming dull later.
(c) Urine stains.
(d) Their runways, often indicated by greasy smears where they pass over or around an obstruction.
(e) Their holes, burrows and nests.
(f) Evidence of their feeding.
(g) The damage they do to food or property.

Rats and mice do not court publicity; they are often quite numerous without actually being seen. Gunderson in Iowa (1943) believes that the number of rats, particularly on farms, may be roughly estimated on the following basis:

No rats seen	0 – 20 present
1 rat seen occasionally	20 – 200 present
1 rat (or more) seen quite frequently	200 – up present

A few rats may often be seen by day on a garbage dump. By night, when the same dump is suddenly flooded with light, the dump may be literally crawling with rats. Although the total number of rats is unknown, in Ontario (or Canada) it may be assumed that the rat population approximates the human population. The Provincial Department of Health states that the Ontario rat population might be approximately 4,500,000. The number of rats picked up after the use of cornmeal-warfarin bait in two area rat demonstrations on 57 Ontario farms indicates an average population of 15–20 rats per farm.

A similar basis of estimating the prevalence of mice is not available.

HABITS

Rats will travel long distances in search of food and suitable living conditions. Even under favourable conditions they roam about the premises, preferring to keep near walls, and to pass behind or under objects, rather than to cross open areas. On the other hand, mice prefer to remain in the vicinity of their nests and seldom wander far afield.

Ontario has but one common species, the Norway rat, sometimes called the brown rat, house rat, wharf rat, or sewer rat. Full grown adults may be 16 inches long, including the tail. The average weight is 11 or 12 oz. The nose is blunt. The ears are of moderate size and slightly hairy. The colour is brownish with the under parts varying from pale grey to whitish.

In general, the Norway rat is a meat eater but its tastes are so varied that it will eat almost any food material. In some localities Norway rats may have a definite preference for certain foods.

Norway rats usually remain near the ground level, seldom going above the first floor of a building. They can climb, but not as readily as other species such as the black rat which, however, is seldom found in Ontario. Nests are usually made in burrows in the ground, under buildings, platforms, lumber piles, etc., and in garbage dumps. The nest is usually of trash and is seldom neat or well-formed. Their tunnels are 2 to 3 inches in diameter and of varying length. Most tunnels have more than one opening to the surface, some of which are usually concealed in grass or under debris. When necessary, Norway rats are able swimmers. They are bold by nature and, when cornered, are vicious fighters.

(B) CONTROL METHODS

There are several methods of rodent control. In the order of their popularity these are: (I) Trapping, (II) Poison baits, (III) Tracking poisons, (IV) Poison gases, (V) Clean up, (VI) Rodent proofing or exclusion.

I. TRAPPING

Trapping is the common method of control in residences, apartment buildings and offices where only a few rodents are involved. This method owes its popularity to the ease with which trapped animals can be picked up and disposed of with a minimum danger of the rodents dying in inaccessible places and giving rise to obnoxious odors.

Although steel jaw, cage and automatic traps are available the commonest type of trap in use is the snap trap. Any trap is practically useless unless it is in good condition and can be set so that the slightest touch will release the spring. It should have a "hair-trigger" action.

Traps should be placed along walls and partitions or against boxes and other objects, with the "trigger" towards the wall or object. When rats or mice are numerous it is more economical and effective to use poison bait than to purchase a sufficient number of traps.

In trapping mice rolled oats are a standard bait. They should be placed on the trigger. A little loose bait should be scattered under the trigger to catch mice that are adept at robbing traps. Bread crumbs, other cereals, peanuts, and raisins are also used as bait. Cheese is not the perfect bait as often supposed. A light string, fastening the trap to some adjacent object will often prevent a mouse, trapped by its foot or tail, from finding a hiding place. If a mouse hole is present, a trap should be set 8 to 10 inches away from it on each side.

Rats are usually more cunning than mice. The following points should be considered when trapping rats:

(a) It is a good practice to bait and place traps leaving them unset for 3 or 4 days. They should then be rebaited, set and placed in the same locations.

(b) If rat runs are present, traps should be placed along the runs, or a short distance to the side, with the trigger towards the wall or other object.

(c) It is advisable to fasten the trap to some object by a 2 to 3 foot length of light wire. This will prevent the trap being dragged into concealment.

(d) Where runways are on beams or pipes, traps should be set so that, when sprung, they will hang below and not clutter up the runway.

(e) On floors, traps may be camouflaged with sawdust or other material which will not interfere with the trigger, or they may be placed under leaning boxes or boards, as long as the trigger is allowed free action.

(f) It is not necessary to wash or smoke traps as the human odour makes little noticeable difference to rats.

(g) Baits: If any preference is shown, determine and use the food being favoured by the rats. Rolled oats, other cereals, bread crumbs, peanuts and raisins, hamburger, bacon or bits of fish are readily acceptable.

(h) If the bait is in fine particles, some should be loosely scattered below, as well as on top, of the trigger. Bacon or bits of fish should be fastened to the trigger by tying or pressing. As some baits spoil or dry out in a relatively short time, baits should be examined daily and all spoiled baits replaced.

It is necessary to "outsmart the rat" when using traps for rodent control.

II. POISON BAITS

Poison baits consist of food materials acceptable to rats, or water, to which has been added a definite proportion of a suitable poison. They are effective and are the most practical method of control when rodents are numerous. They may contain a slow-acting or a quick-acting poison. Baits containing a slow-acting poison are the safest for general use. Baits containing quick-acting poisons, when properly used, are effective in reducing heavy rodent populations. As these baits frequently result in bait shyness it is usually advisable to follow up with a slow-acting type of bait to obtain satisfactory control.

General Precautions

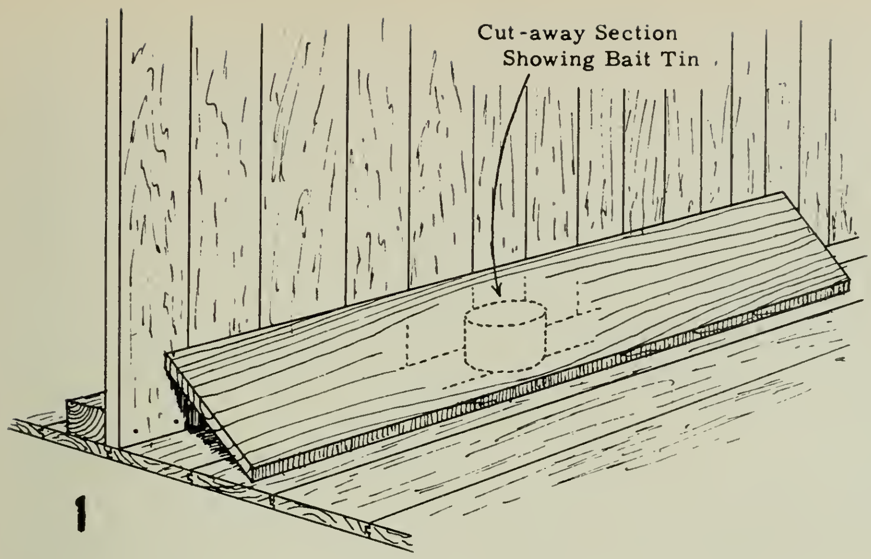
All poisons used as rodenticides are dangerous to humans, pets and other animals. Care must be taken to prevent accidents; all poisons and unused baits should be kept in a safe place, permanently labelled POISON and locked up. Utensils and equipment should be washed immediately after use.

A record should be kept of all poison baits used and where placed. As poison baits are picked up after use, the list of placements should be checked off to ensure that none has been left as a hazard to humans or animals. All portions of baits and unused baits should be burned or buried.

Dead rats should be picked up each morning and should be burned or buried.

TYPES OF BAIT STATIONS

1. Leaning Board
2. Board Shelter
3. Drainage Tiles
4. Bait Box



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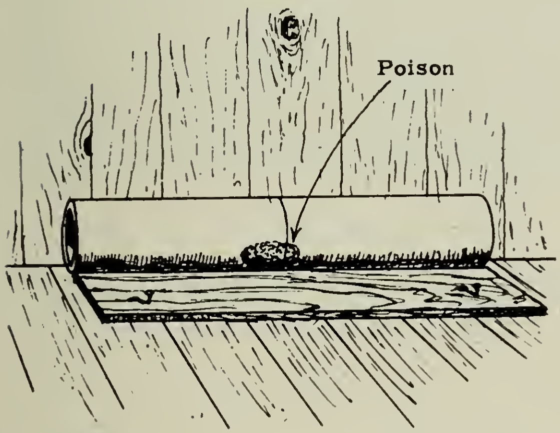

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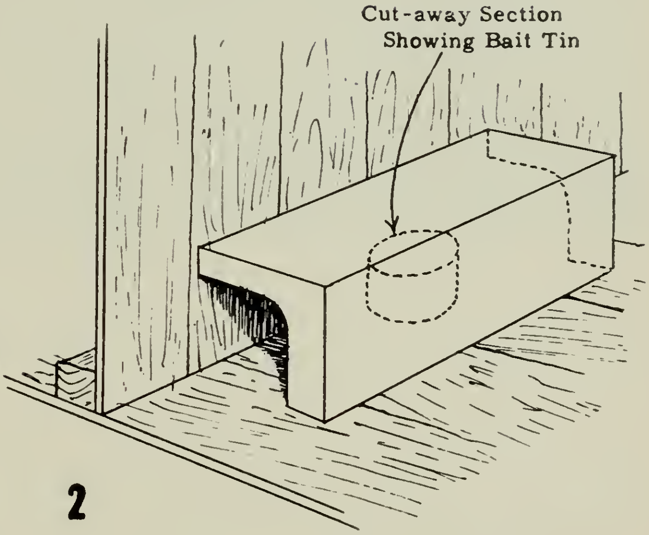

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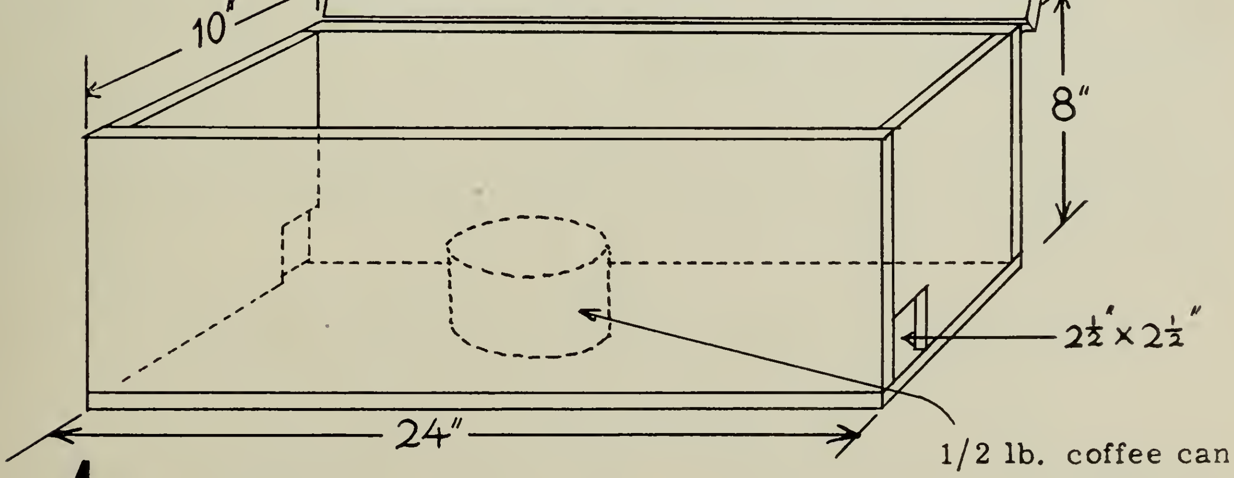

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Bait Stations

Poison baits should never, under any circumstances, be used indiscriminately. Bait stations, whether consisting of bait boxes or other means of protection, should be used with all poisons. There is always danger of children or unauthorized adults tampering with the poison bait, or danger of pets or other animals opening or upsetting the boxes. Openings in bait boxes should be approximately 2½″ square (or in diameter) in order to admit rodents but exclude larger animals.

Bait stations not only protect children, pets or other animals but also serve to keep dust and foreign matter out of the bait.

Antidotes

In cases of accidental poisoning with registered commercial rat and mouse poisons, the proper antidote to be used is printed on the package label.

Placing Baits

Bait stations should be placed in rat runways or near them, such places as beside walls or partitions and boxes or under leaning boards. In farm buildings one of the most effective locations is in the poultry house, particularly if deep litter is used. The piggery and haymow are also good locations. Usually cereal baits are relatively inacceptable in granaries as there is too much other food available. If no other source of water is handy, it is advantageous to place a low container of water in or near the bait station as many poisons make the rodents thirsty.

(a) Slow-acting Poison Baits

Slow-acting poisons for use in rodent control are the most recently developed rodenticides. The commercially available poisons of this type are warfarin and the water-soluble sodium salt of warfarin. One dose is rarely fatal. Small amounts must be eaten for at least 2 to 6 successive days before death results. These poisons act as anticoagulants and, when taken on successive days, cause the animal to bleed to death, usually internally. Warfarin poisoned animals gradually become weaker until they die. If these poisons are not taken over a sufficient number of successive days the animal will recover. In addition to their relative safety to use as rodenticides, these poisons do not produce bait shyness, the rodents continuing to take them until they die. With these materials, prebaiting is not necessary.

1. Warfarin Baits

Warfarin baits usually consist of fresh, coarsely ground corn-meal with warfarin added to constitute 0.025% of the bait.

FORMULA

19 parts by weight of fresh coarsely ground cornmeal
(or rolled oats).
1 part by weight of warfarin (0.5%).

Warfarin may be purchased as a 0.5% product and mixed with cornmeal or rolled oats. Since mixing must be done thoroughly and, since few individ-

Warfarin bait station in hen house with shallow litter. Note rat damage to box.

uals take the trouble to be thorough, it is more practical to buy ready-mixed or prepared warfarin bait.

Warfarin baits should be placed in containers such as one-half pound coffee tins in the bait boxes or in other protected bait stations. The supply of warfarin bait should be kept replenished as long as it is being taken. This may be for a period of two to several weeks, depending on the number of rats present. The baits can sometimes be made more acceptable by adding 2–3% of mineral or corn oil, well mixed with the bait. If, after 4 or 5 days, the bait is not being eaten, it is advisable to move the bait station to another location. Using warfarin baits, better results are obtained if bait stations are placed in all areas where there is evidence of rodents.

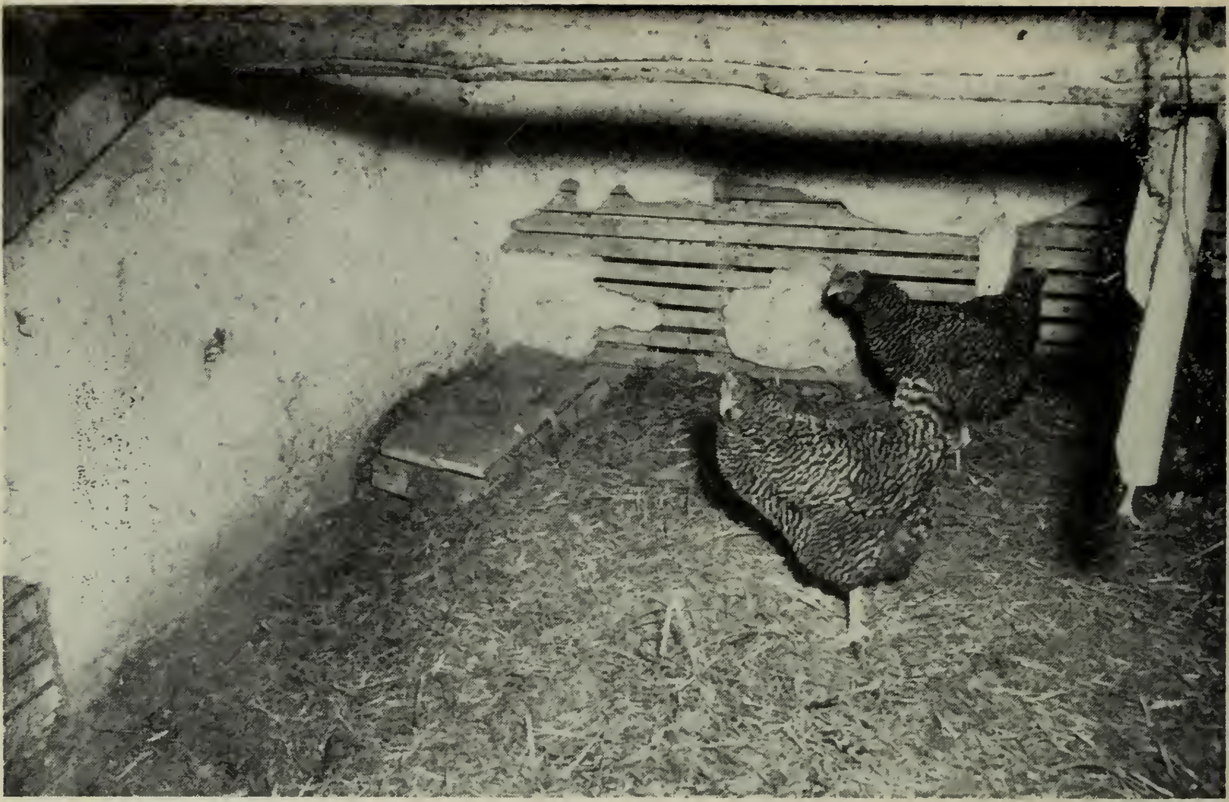
If a cat or other animal ate warfarin poisoned rodents for several successive days, that animal might also be poisoned.

Since warfarin bait is left in the containers for several days and since it spoils or moulds when damp, baits should be placed in dry situations. After the rat infestation is apparently cleaned up it is advisable to maintain one or two warfarin bait stations to take care of survivors, or newcomers. To control the rats on an average Ontario farm, 5 pounds or more of warfarin bait would be required.

Warfarin baits, as outlined for rats, are effective in the control of mice, but should be placed in shallow containers such as tin lids and saucers.

2. Water-soluble Sodium Salt of Warfarin

At the present time this material is available commercially under the trade name, Warficide. It is marketed in $\frac{1}{3}$ ounce packages, sufficient to treat one quart of water.



Warfarin bait station in henhouse with deep litter.

To facilitate the handling of the very small amounts required silica grains (sand) are coated with Warficide. When added to water the Warficide readily dissolves, the silica grains settling on the bottom of the container. The directions and precautions for the use of warfarin apply to the use of Warficide. Although open containers may be used, pint or quart chick founts are preferable as their use reduces the danger of spillage and the amount of surface exposed to collect dust and debris.

Warficide is particularly useful in controlling rodents on premises where an abundance of food is available, as in farm granaries, near the chop box, in flour mills, and in feed warehouses.

Present indications are that it is effective in the control of mice.

(b) Quick-acting Poison Baits

These are baits which contain poisons, one dose of which is usually fatal. The health hazards to humans and animals are much greater when quick-acting poisons are used in rodent baits.

Quick-acting poison baits are mainly used in rat control. The baits may be almost any food material attractive to rats and compatible with the poison used. Some baits used are dry, others wet. Some poisons are used with oily bait materials. Based on research in the N.E. United States (O'Connor et al 1934) some common bait materials in order of their preference by rats are: raw meat, raw fish, rolled oats, whole meal, fresh vegetables and fresh fruits. Some commercial pest control operators prefer to use a mixed bait and claim that the addition of mineral or corn oils, molasses or peanut butter will make the bait more attractive. It should be borne in mind that in hot weather, or warm humid weather, some baits spoil more rapidly than others and may be acceptable to rats for relatively short periods.

Warfarin bait station in alley way of pigpen.

Better results with baits containing quick-acting poisons are obtained if prebaiting is practised. Small quantites of unpoisoned bait are placed in selected locations, preferably in bait boxes, to allow the rats to become used to it. Prebaiting should be repeated several nights in succession. If the bait is not acceptable to rats, prebaiting should be continued for a longer period and or the ingredients changed. When the bait has been accepted, the prebait is replaced with the poisoned bait, placed in the same situations.

Some Quick-acting Poison Baits and Formulas

1. Red Squill

This poison, until warfarin was introduced, was the safest for use by the average individual. It is not as efficient as other poisons, mainly due to the lack of toxicity uniformity in different lots of the poison: cats, dogs, chickens and hogs, frequently will not eat squill baits; or if they do, they will quickly vomit it up. This does *not* remove the necessity of placing poisoned baits where they will be inaccessible to children, pets or other animals.

FORMULA

Bait as cereal, fish, bread crumbs	9 parts by weight
Red squill powder	1 part by weight

thoroughly mixed together.

Dry bait materials can be used at the rate of 1 measuring cup of the bait to 1 level teaspoonful of red squill powder. Stir powder in *thoroughly.*

2. Mouse Seed

Poison-coated (usually strychnine) grains or seeds are commonly used for mouse control, in residences and buildings. This should only be used in attics, store rooms, or places *which can be kept locked.* It should never be scattered but be placed in tin lids, saucers, or other shallow containers in places where it is accessible to mice but not to children or pets. It should never be used in kitchens, restaurants or food establishments, *where there is always a danger of contaminating food.*

3. Zinc Phosphide

This is a heavy, dark, grey powder with a faint odour of phosphorous. It is more poisonous than red squill. Zinc phosphide should be weighed, mixed with the bait and handled in a well-ventilated room or out of doors. Rubber gloves should be worn, when mixing and distributing baits.

Formula

Bait	96–100 parts by weight
Powdered zinc phosphide	1 part by weight

Corn oil, mineral oil or glycerine may be added to make the poison adhere, and the bait more palatable to the rats. It is usually added at the rate of 15 to 24 ozs. per 100 lbs. of bait, *after* the bait and zinc phosphide have been uniformly mixed. The oil, preferably warmed, is added slowly and stirred in with the bait and poison. Cereals or bread crumbs, alone or with fresh fish or hamburger added, are commonly used as a bait with zinc phosphide.

Ontario Department of Health regulations for extermination state that strychnine and zinc phosphide shall not be used for extermination

(a) in a room where food or drink for human consumption is stored, prepared or served,
(b) in a room occupied by human beings, or
(c) in an area from which all persons cannot be excluded.

4. Antu

This is a relatively new poison approximately 50 times as poisonous as red squill. It has been useful for the control of Norway rats. It is not as toxic to mice and field rodents. It will kill dogs, cats and pigs but is less dangerous to poultry and humans and *must* be used carefully. It is a fine bluish powder, insoluble in water. As a powder it should be stored in a dry place. It may be dusted on cut, moist baits such as apple, ground meat, fish or even poultry heads.

Sublethal doses of Antu will make rats immune to this poison for periods up to at least three weeks. It is usually useless therefore, to rebait with Antu within this period.

Formula

Bait	100 parts by weight
Antu	2 to 3 parts by weight

Ontario Department of Health regulations for extermination state that Antu shall not be used in baits for extermination in an area

(a) inhabited by or readily accessible to human beings, or
(b) where food or drink for human consumption is stored, prepared or served.

5. Phosphorus

Many commercial rat and mouse poisons in the form of pastes and syrups are based on yellow phosphorous. Children, pets, and even adults, sometimes eat the pastes or syrups, with serious results. These rodent poisons are more of a hazard for use in residences and where accessible to children and animals than are other types in common use.

6. Other Poisons

There are a number of other poisons, commonly used or sold for rodent control. Some of these are relatively inefficient, others are deadly to rodents, other animals and humans, and should not be used by inexperienced individuals. The average person, rural or urban, would be well advised to select a relatively safe poison for bait purposes.

III. TRACKING POISONS

Some poisons in the form of powders are dusted along rodent runways, around their burrow openings, or in other places where rodents must pass over them. In cleaning themselves, the poison is taken into the mouth with fatal results.

Tracking poisons are *dangerous* to use under ordinary conditions in homes or on farms. They should never be used wherever there is the slightest danger of food contamination, where humans or animals, other than rodents, will come in contact with them or where they may be blown about by draughts. It should be remembered that rodents do not confine their activities to any one part of the premises but may pass from floor to shelves, clothes, food and utensils, thus creating a serious danger of poisoning when tracking poisons are used.

The Ontario Department of Health regulations for extermination state that Antu shall not be spread as a powder in rooms

(a) where food and drink for human consumption is stored, prepared and served, or
(b) leading directly into rooms where food or drink for human consumption is stored, prepared or served.

The same precautions apply to the use of DDT powder.

The commonest tracking poisons are:

(a) Antu

This poison has been used effectively by trained personnel as a tracking poison for rats and mice.

An invitation to rats and mice.

(b) DDT

This insecticide has been used as a tracking poison in the control of mice. Although only slightly more poisonous than red squill, it is an accumulative poison and small quantities, repeatedly ingested, can result in serious illness.

IV. POISON GASES

Poison gases have a restricted use in the control of rats and mice. Such gases as hydrocyanic acid gas and methyl bromide are used to kill rodents within their burrows or within tightly constructed buildings. Due to the health hazards involved they can only be used by licensed personnel.

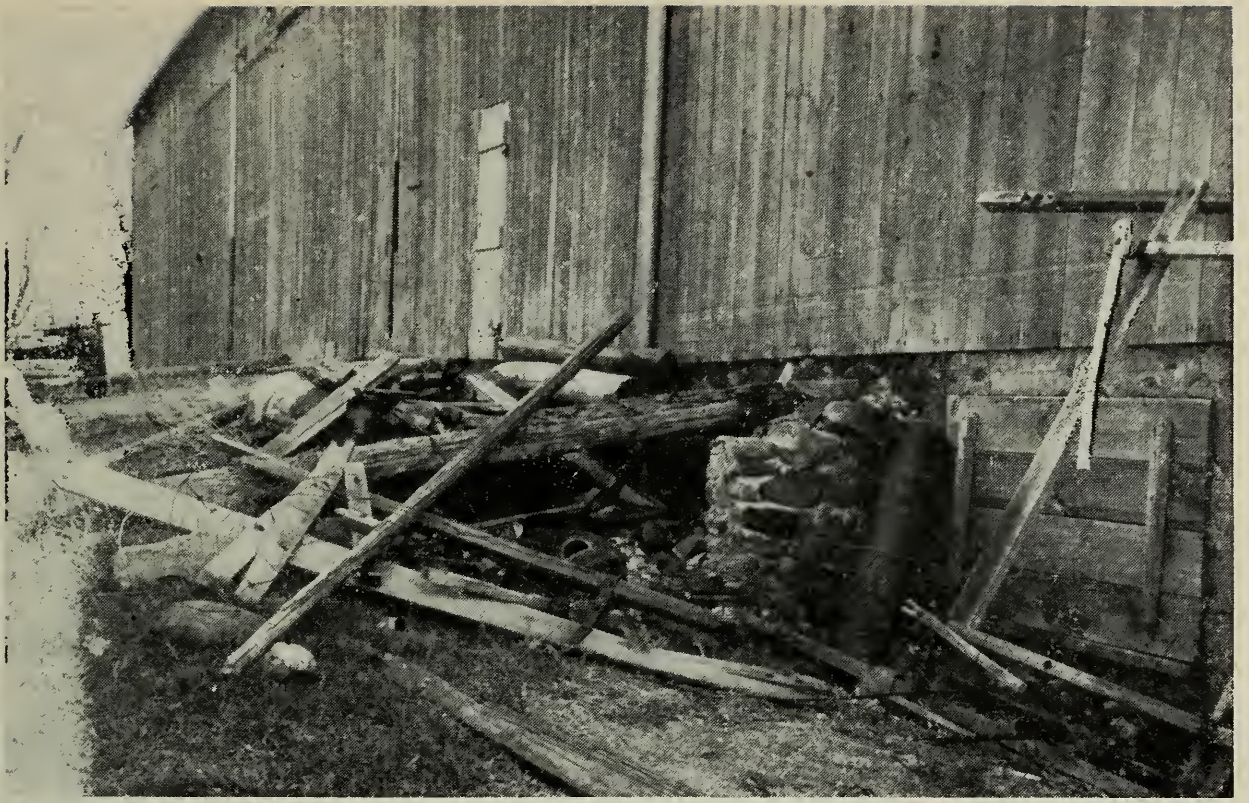
V. CLEAN UP

By clean up is meant the removal and destruction of all accumulations of papers, cartons, boxes, old lumber and debris that would serve as sheltering places or harborage for rats or mice. A thorough clean-up should precede other methods of rodent control.

VI. RODENT-PROOFING OR EXCLUSION

In many buildings this method is impractical due to cost. Where practical it is the only permanent method of rodent control. It involves good housekeeping practices and making buildings rodent proof.

Rodent-proofed buildings should have no unprotected openings more than 3/8 inch in width. Some mice can pass through openings 1/2 inch in width and



Typical farm rat harborage.

young rats require but slightly wider spaces. In practice, rodent-proofing houses, and larger buildings necessitates concrete floors and footings and solid exterior walls with no holes or large cracks. All openings should be screened with ¼ inch mesh metal screens or grills. Metal sheathing (or cement) should be used around all openings for pipes or conduits. Doors and windows should be tightly fitted and should not be left open unless adequately screened. Good maintenance and frequent inspection, particularly subsequent to even minor repairs or alterations, is necessary. Smaller buildings should be elevated at least 15–18 inches above the ground.

Protection of food entails the use of rodent-proof storage space or bins for bulk storage. In homes, rodent-proof store rooms, metal or wooden rodent-proof containers, covered crocks, glass jars, small garbage cans, etc., should be used.

The problem of exclusion is simplified if garbage is kept in closed rodent-proof containers, and boxes and debris are not allowed to accumulate to form harborages for rodents.

BULLETIN 499 MARCH, 1954

SHEEP HUSBANDRY IN ONTARIO

ONTARIO DEPARTMENT OF AGRICULTURE
PARLIAMENT BUILDINGS, TORONTO, CANADA

CONTENTS

Page

Introduction 1

Sheep Breeding 5

Housing and Equipment 12

Feeds and Feeding 20

Management of the Flock 28

Marketing Lambs 38

Disease Prevention 41

Parasite Control 45

Sheep Protection 50

SHEEP HUSBANDRY IN ONTARIO

This bulletin was prepared by a Committee consisting of staff members of the Ontario Agricultural College, the Ontario Veterinary College, the Kemptville Agricultural School and the Live Stock Branch of the Ontario Department of Agriculture.

FOREWORD

Sheep production should be looked upon as a business just as is the case with dairy cattle or any other class of live stock. It is rather doubtful, under present day conditions, if a small flock can be profitably maintained as a side line on Ontario farms. Accordingly, the information found in this publication has been compiled and presented with the hope that it will be helpful to those who may be interested in this particular class of live stock. The aforementioned information is based on the results of the most recent investigational work at different universities and colleges, combined with practical experience, and, therefore, should serve to bring about more profitable enterprise in the hands of those who may be interested in this important phase of animal production.

INTRODUCTION

Sheep as old as man

History records that sheep existed on this earth 5,000 years before the birth of Christ. Down through the ages countless generations have debated the question, "Did sheep antedate man, or did man inhabit the earth before sheep?" Although this mystery may never be solved, it has been established that sheep were among the first animals to be domesticated. In the early centuries of ancient times a man's worth was measured by the size of his flock. During biblical times and after, sheep and particularly lambs were represented as the symbols of innocence, purity, and righteousness.

Columbus introduced sheep to the Western Hemisphere

In 1493 sheep were landed in Cuba by Columbus on his second voyage to America. A few years later some of their descendents were transported to Mexico where they became the progenitors of the large flocks which were subsequently established in the Spanish territory of Texas, Arizona, and New Mexico.

The first sheep to reach the British colonies on the American continent arrived at Jamestown, Virginia, in 1609. However, it was not until 150 years later that they became widely distributed in the new world. In the years that followed, sheep moved westward as new frontiers were explored and as new land was settled, and are now kept in all parts of North America inhabited by man, except in the far north.

Sheep developed as a dual purpose animal in England

During the first 1,700 years of the Christian era sheep were prized for their fleeces, wool being one of the few fibres available for processing into clothing. When meat became scarce in England during the eighteenth century, some of the leading live stock producers began to consider their possibilities in meat production. Robert Bakewell, a native of Leicestershire who lived from 1725 to 1795, was the first man to make an outstanding contribution to the development of the mutton-type sheep. He originated the breed which bears the name of his native county. His shining example proved an inspiration to others who, adopting his principles of sheep breeding, played their part in originating new breeds and establishing Britain as the homeland of most of our modern breeds.

Sheep population higher fifty years ago

The following table reveals the sheep population of Canada and of Ontario in each of the census years of the present century:

Table 1

Year	Canada	Ontario
1901	2,510,239	1,046,456
1911	2,174,300	742,188
1921	3,203,966	1,081,828
1931	3,608,340	1,035,000
1941	2,839,948	661,775
1951	1,478,737	360,201

In 1901, 91.4% of Canada's sheep were located east of the Ontario-Manitoba boundary. However, by 1941 when the sheep population was only slightly higher, the numbers were divided almost equally between east and west. In the next decade the population increased to an all-time high of 3,726,000 in 1944, and then fell into a sharp decline which finally resulted in the low point for the century being reached in 1951. The decline was greater in the West than in the East, as indicated by the fact that approximately 60% of the total sheep were located east of Manitoba when the last census was taken. Generally, flocks in Western Canada are quite large. In Ontario flocks have always been small, sheep being considered a side line.

The majority of Canada's purebred flocks are located in this province, with 512 of the 1148 members of the Canadian Sheep Breeders' Association in 1951 being residents of Ontario. In addition to selling a great many ewes and rams in the province, these breeders made the greatest contribution to our export trade in purebreds, accounting for 2,345 of the 3,218 head exported in that year.

Sheep population influenced by war

During the present century two world wars have exerted a powerful influence on sheep production. In World War I farmers were urged to produce more sheep in order to meet the increased demand for meat and wool. They responded to the appeal and were rewarded for their efforts when lamb and wool prices reached exceptionally high levels during the last stages of the war and immediately after. The story was repeated in World War II, particularly after Japan entered the conflict. For a time it was feared that the shipping lanes between Australia and this continent might be severed. Farmers retained a high percentage of their ewe lambs, and thus brought the total number of sheep in this country to an all-time high by 1944. However, interest began to wane fast when hostilities ended and particularly when it was announced that world stock piles of wool were sufficient to meet demands for several years. This surplus, however, disappeared much sooner than expected.

Canadians not large consumers of lamb

An analysis of world meat consumption reveals that Canada ranks sixth on a per capita basis, being exceeded by Australia, New Zealand, Argentina, Uruguay, and the United States. Nevertheless, that lamb does not occupy a prominent place in the Canadian meat diet is shown by the following table:

Table 2—Per Capita Meat Consumption—Canada

Year	Beef	Pork	Veal	Lamb & Mutton	Other Meats	Total
1951	44.1	67.8	7.7	2.6	11.7	133.9
1950	50.5	60.8	9.2	2.5	11.1	134.1
1949	56.5	59.2	9.1	3.0	10.7	138.5
1948	57.5	53.9	10.9	3.5	9.5	135.3
1935-39 av.	54.7	39.8	10.5	5.6	7.7	118.3

N.B. Other meats include canned and processed meats such as bologna, but do not include poultry.

In recent years Canada's exports of lamb and mutton have approximated her imports of those commodities, e.g. in 1951 Canada exported 31,727 sheep and lambs, and 2,737,200 pounds of lamb and mutton. During the same year imports of lamb and mutton totalled 3,449,204 pounds. For the most part the product was exported during the height of the Canadian lamb marketing season, while imports were made during the winter months when marketings from home production were at their lowest point.

Canada—a deficiency producer of wool

The following table reveals Canada's position with respect to production and imports of wool:

Table 3

Year	Canadian Production	Imports
1951	6,882,000 lbs.	69,012,000 lbs.
1950	9,531,000 "	82,241,000 "
1949	9,835,000 "	70,720,000 "
1948	11,915,000 "	95,181,000 "

Canada produces a very small percentage of her total wool requirements hence sheep production would have to be increased many times in order to make up the deficiency between local supply and demand.

Synthetic products replacing wool

In recent years many new fabrics such as rayon, nylon, and orlon have been produced. These fabrics are finding a ready market in Canada, and in some instances are replacing garments that would otherwise be made from wool. Despite this fact, the demand for wool is still relatively high. Canada's population is growing rapidly, and many of her people live in areas where woollen clothes are a necessity during several months of the year. Under the circumstances total wool requirements are not likely to diminish seriously even though substitutes may be offered, and garments made from combinations of wool and synthetic fabrics may come into more general use.

Factors affecting sheep numbers

When Ontario had a higher sheep population most farmers kept small flocks. They were truly mixed farmers as the result of engaging in a wide variety of enterprises. However, in recent years farmers have become more specialized. On many farms, wide, power-propelled machinery has replaced narrow, horse-drawn equipment, making wider gates necessary. In some cases inside fences have been removed entirely or have been replaced with a type of fence that can be moved as circumstances warrant. Persons adopting this method of fencing have found that it does not lend itself to sheep production, so have disposed of their flocks.

In other instances farmers were obliged to keep sheep on the same pasture year after year because of limitations in the area suitably fenced. This practice proved satisfactory until the flock became infested with parasites. Despite treatment, the infestation invariably became more serious unless sheep could be transferred to new pastures. The flock became less profitable so was sacrificed because of inadequate facilities for parasite control.

Dogs and predatory animals have been the third contributor to the declining sheep population. Although municipal councils are required to reimburse owners for losses, a flock that has been terrified or wounded by dogs seldom does as well thereafter. The real trouble may not become manifest until the next lambing season. Owners become discouraged and decide to go out of the sheep business, particularly if attacks are repeated.

The place of sheep in the Ontario farm economy

Canada produces many agricultural products in excess of domestic requirements but lamb and wool are not among them. Consequently sheep production can be expanded without incurring the danger which usually results from over-production. The prospects of a ready market for lamb and wool are often interpreted as an open invitation to engage in sheep production. However, before plunging into the business a person must divest himself of the delusion that sheep are no trouble and do not require much care and attention. It is true that sheep do not require as much daily attention as other classes of live stock, but they demand particular attention at certain periods, e.g. breeding, lambing, shearing, dipping, and treating for internal parasites. Neglect of the flock at the times when these tasks should be attended to may well determine the difference between profit and loss.

Ontario has a great deal of marginal land and expert opinion is divided regarding its use. Some maintain that it should be planted to trees, while others claim that it will yield higher returns if left in grass. Unfortunately a great many owners are not in a position to wait for the returns that will undoubtedly accrue from a crop of trees, so they are obliged to rely on the annual revenue obtainable from pasture. Under such conditions sheep should receive a top priority as the medium for marketing the grass provided, of course, that the land is not located in an area where predatory animals abound. Cattle will not make such efficient use of this type of pasture because of the greater amount of energy expended in getting enough to eat.

It is a fallacy to associate sheep with rough pastures only. Since this class of live stock is the most efficient converter of grass, higher returns can be expected from improved pastures. However, increased returns will accrue only if sheep raising is undertaken as a business and not as a side line. In the past few years several large sheep flocks have been established in Ontario and their owners depend upon them for their main source of income. In some cases registered seed grain and grass seed are produced as additional sources of revenue. This type of business lends itself to large scale operation with the minimum of labour. Even so, the operators are always in a position to give prompt attention to those requirements of the sheep flock which are urgent.

Ontario should have a larger sheep population. There are many opportunities in sheep production, but a profitable enterprise will not result unless these opportunities are seized by persons who are prepared to treat sheep production as a business. This simply means that the same basic principles of breeding, feeding, management, and disease control as they are applied in the production of any other class of live stock must be practised.

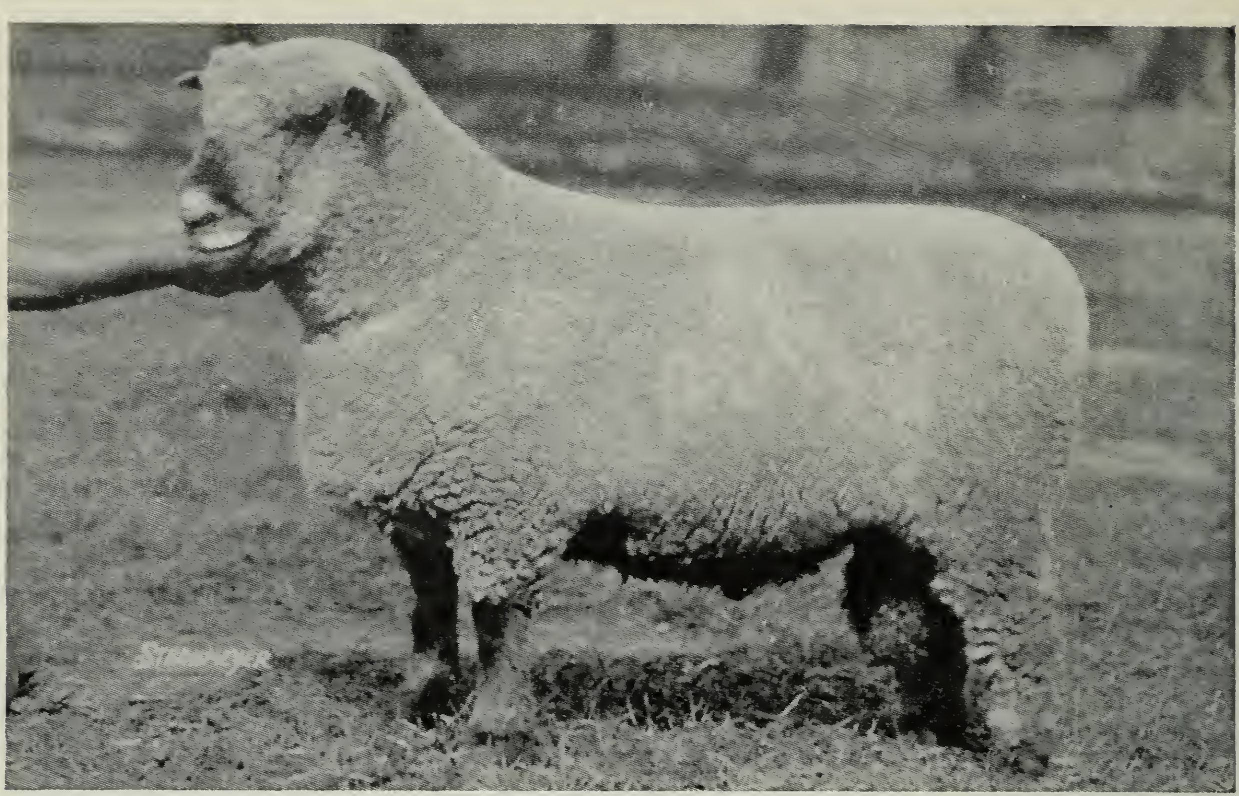
A Suffolk Ram

SHEEP BREEDING

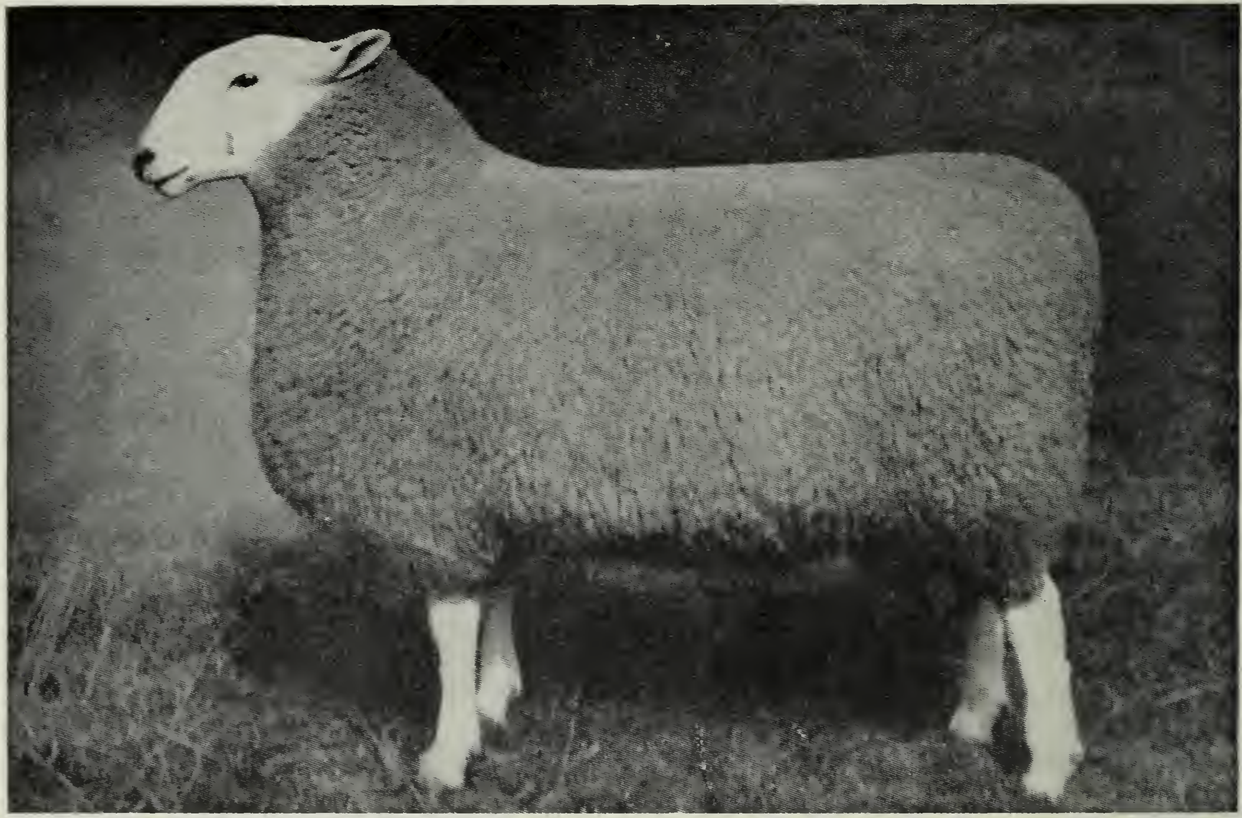
Breeds

Successful production of sheep depends to a considerable extent on the ability of the producer to select and propagate the kind and breed of sheep which will yield the largest returns. The selection of the breed and the general breeding plan to follow are two points in sheep production on which it is most difficult to give definite advice. Breeds of sheep vary greatly in many characteristics such as type, wool, colour, and temperament. Each breed has been selected and improved to meet a certain set of local conditions. The sheep is a dual-purpose animal producing two marketable products—meat and wool. Some breeds have been selected chiefly for their ability to produce wool and are, therefore, known as wool breeds. Others have been developed for their meat-producing properties and are classified as mutton breeds.

The wool-producing breeds, partly because they have the flocking instinct, are better suited to range conditions. In Canada they are confined chiefly to the short grass country of the Western Provinces. Range-type sheep are not suitable for producing early-maturing market lambs. Their chief attributes are hardiness, flocking instinct, ability to graze over large areas, and high quality wool. For purpose of classification, the breeds that come under this group are called the **fine-wooled** breeds, the chief ones produced in Canada being the Rambouillet and the Corredale. Except as a basis for a grade flock foundation, the fine-wooled breeds have little to offer the Ontario sheep producer. As foundation stock for commercial flocks, Western range ewes have proven very satisfactory. They should be mated with good mutton-type sires.



An Oxford Down Ram



A Leicester Ram

Another group of breeds are classified as **medium-wooled.** Included in this group are all the **down** breeds and also the Cheviot. They are all of British origin and may be listed as follows: Southdown, Shropshire, Hampshire, Oxford, Dorset, Suffolk, and Cheviot. They vary in size from the small, compact Southdown to the larger, rangier Oxford. The medium-wooled breeds have been bred primarily for mutton, although some of them produce excellent wool.

The colour of the face and legs ranges from white in the Cheviot to black in the Suffolk, and the wool covering of the face and legs varies from no covering in the Suffolk to a heavy covering in the Shropshire. The majority of the sheep on Ontario farms belong to the medium-wooled class.

The third class of sheep is called the **long-wools.** This group includes such breeds as Leicester, Lincoln, Cotswold, and Romney Marsh. The sheep in this group are larger than in the other classes. They have longer, coarser wool with a more open fleece. In general they do not mature as early as the **down** breeds.

Of the above four long-wooled breeds, the Leicester is the most popular in Ontario. In the number of registrations in Canada they were in third position in 1952, the number being exceeded only by Suffolks and Oxfords.

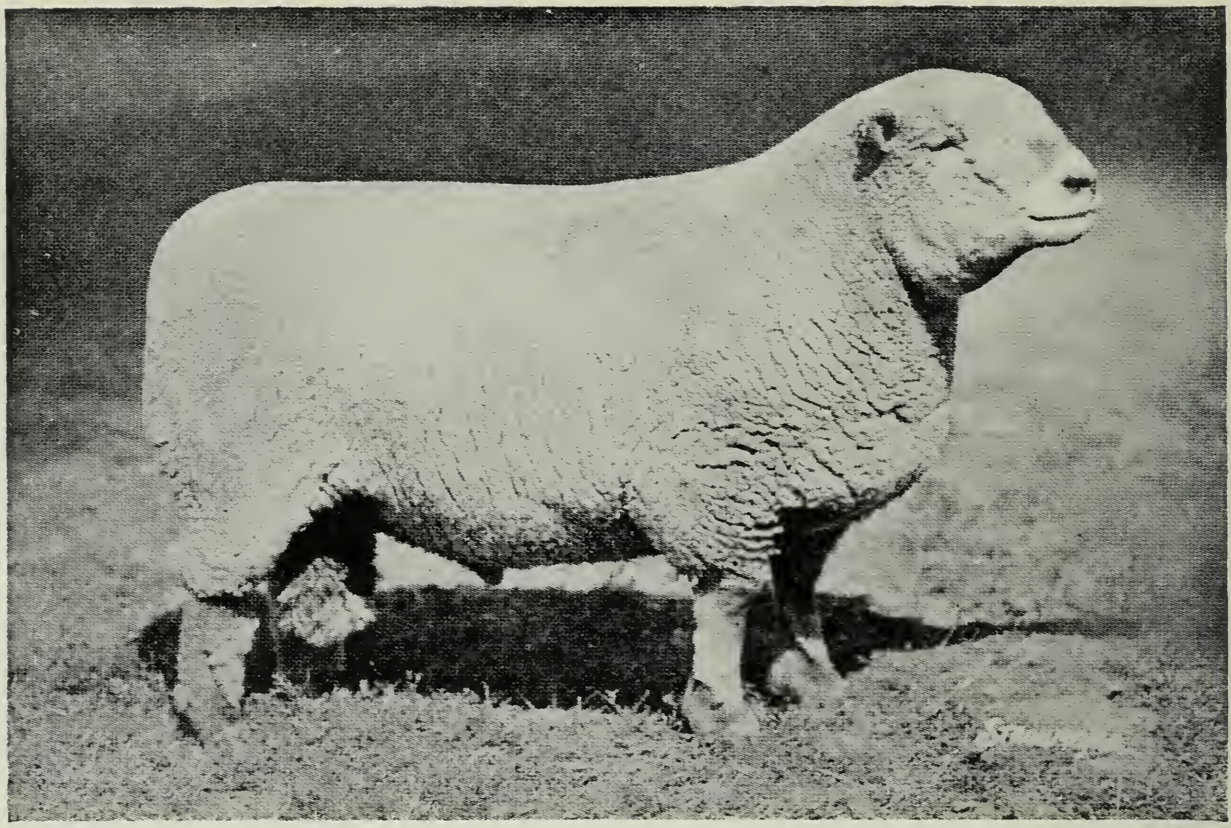
Table 4—Sheep Registrations in Canada

Breed	1922	1932	1942	1952
Shropshire	2935	2809	2064	835
Leicester	923	1175	1608	1176
Oxford	1870	3990	3277	1552
Cotswold	258	136	258	84
Lincoln	178	99	466	127
Dorset	182	207	263	255
Hampshire	462	1183	2287	733
Southdown	338	1019	2543	1098
Suffolk	404	1697	5526	4914
Cheviot	173	263	310	795
Black Face	—	—	8	1
Romney Marsh	7	3	57	44
Rambouillet	17	70	786	318
Corredale	—	—	68	131
Merino	—	—	—	1
Ryeland	—	20	—	18
Kerry Hill	—	—	49	17
North Country Cheviot	—	—	—	270
Karakul	—	—	34	63
Total	**7747**	**12,671**	**19,604**	**12,432**

A picture of Canada's sheep registration covering the period of thirty years is shown in the above table. In 1922, the Shropshire breed predominated in the number of sheep registered, with the Oxford showing in second place. Ten years later, in 1932, the Oxford replaced the Shropshire for first place. In 1942, Suffolk registrations were well to the fore, having more sheep recorded than the next four leading breeds.

Exhibition classes in Ontario

Ontario Class A Fairs offer prize money for ten breeds of sheep. The list includes three breeds of the long-wooled class and seven breeds of the medium-wooled class. Owing to the lack of fine-wooled breeds in this Province, no classes are offered for Rambouillets or other breeds belonging to the fine-wooled group. The following breeds are provided classes in Ontario Class A Fairs: Shropshire, Southdown, Oxford, Hampshire, Suffolk, Cheviot, Dorset Horn, Leicester, Lincoln, and Cotswold.



A Southdown Ram

Considerations in establishing a flock

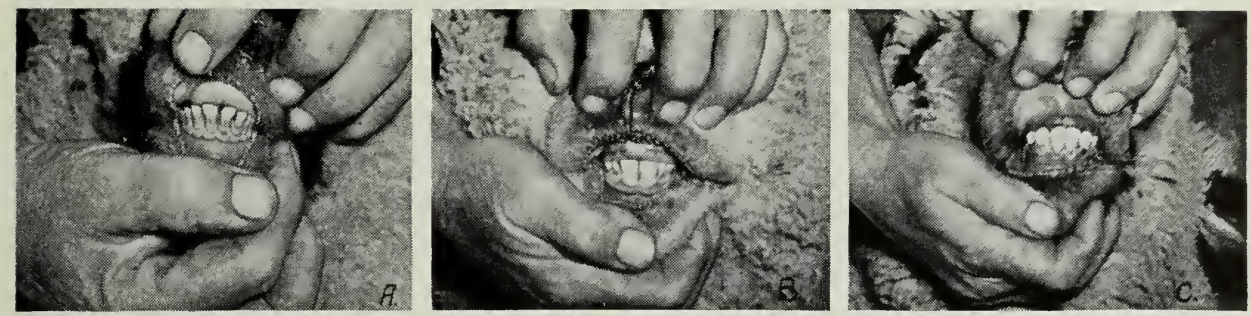
The proper procedure to follow in starting sheep raising depends on many factors: experience, type of farm, availability and cost of foundation stock, equipment available, etc. The novice or inexperienced person should not attempt to gain his experience with a large outlay of capital. There are many facts to be learned in the profitable management of the flock, and these pointers can be obtained just as well and with less risk with a small flock. It would be inadvisable, therefore, for the novice to start sheep raising on a large scale before he has gained needed experience in all phases of sheep management. After this experience has been obtained and he is assured that sheep production fits into his farming plan as a profit-making enterprise, he can enlarge his holdings to a point where it should become a profitable venture.

As a general rule, it is much better for the beginner to purchase grades rather than purebreds. Grades are more easily secured, cost less money and involve less financial risk. In addition, the successful management of purebreds requires much more experience. The purebred breeder should have a real understanding of the principles of live stock breeding. He should be familiar with the characteristics of the common breeds and know their strong and weak points. He should be a good live stock judge and be capable of properly selecting his animals. These factors and many more are essential to make purebred breeding a success. For these reasons it would be unwise for the beginner to start with purebred stock.

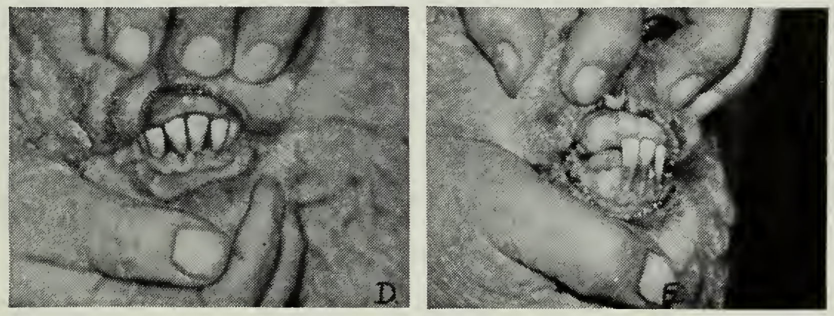
Starting a flock

The commercial sheep producer desires a medium-sized sheep that will produce finished market lambs weighing from eighty pounds to one hundred pounds at five months of age. He wants ewes that produce a large poundage of

How to determine the age of sheep



A. Lamb **B. Shearling** **C. Two shear coming three**



D. Full mouth **E. Broken mouth**

good quality lamb per ewe. He also prefers sheep with open faces and little wool around their eyes. The wool clip should yield about eight pounds per fleece and be free from black fibres. The Breeders of purebreds should give greater consideration to the requirements of the commercial producer.

Sometimes the beginner experiences difficulty in starting a flock. Healthy breeding ewes of a suitable type and quality under five years of age are difficult to find and purchase. Many of the ewes shipped to market are unsatisfactory for breeding. Some of them are too old, or have bad udders or broken mouths; others are marketed because they are non-breeders or have produced poor lambs. Also, few breeding ewes are available on the market at one time.

Because of these unfavourable conditions, it is almost impossible to obtain suitable breeding ewes on the regular market. Occasionally it may be possible to buy directly from a reliable flock owner who is planning to dispose of some of his ewe lambs and healthy sound ewes. When this means of purchasing is possible it is more satisfactory than buying ewes on the open market.

A considerable number of Western range ewes have been brought into Ontario for the purpose of establishing foundation flocks. These sheep are purchased in the fall of the year when the rancher makes his annual fall sorting. The ewes have to be carefully selected by a responsible and experienced sheep man and brought east in carload lots. According to the reports received from sheep owners who have purchased Western ewes, these sheep have proven satisfactory. When this Western stock is mated with blocky mutton-type sires, they usually produce excellent market lambs. The ewes are usually free from internal parasites and, if purchased when not over five years of age, they will continue to produce good lambs for another two or three years. The cost of transporting the ewes adds considerably to their purchase cost.

Determining the age of sheep

Sheep men always "mouth" or examine the teeth of sheep they are about to purchase to see if the age is as represented. A ewe has only five to seven

A Group of Western Range Ewes

years of useful and productive life, and the addition of a year or two to her age makes a considerable difference in her value.

The system usually followed in mouthing sheep is to determine the number of permanent incisor teeth in the lower jaw. There are no incisors in the upper jaw. When the centre pair of lamb teeth has been replaced by a pair of permanent teeth, the sheep is a yearling; two pairs of permanent teeth indicate a two-year-old; three pairs indicate a three-year-old; when all of the lamb teeth are gone and there are four pairs of permanent teeth, the sheep is said to have a full mouth and is a four-year-old or older.

If the sheep is beyond the age of four years, one must estimate the age by the width of teeth, their firmness in the jaw, and the extent of wear. An old tooth is narrow and not firm in the jawbone. The exact age of old sheep is not important. They are usually bought and sold on their condition as "solid-mouthed", "broken mouthed", and "gummers".

Exceptions to the general dental table may be found. For example, a late lamb may still show a lamb mouth the following summer, or an early lamb may show a three-year-old mouth in September when it is actually a two-year-old.

Crossbreeding

Crossbreeding is fairly regularly practised in many countries in the production of market lambs. Most of the market lambs produced in Great Britain are the product of crossing. In Canada we have, in the past, adhered closely to the grading-up practice. Advocates of crossing claim marked advantages from the practice—increased vigour, more weight of lamb and wool per ewe, and improved quality of product.

The Central Experimental Farm and several of the Branch Farms have been conducting crossbreeding experiments for the last few years. In a recent report, they state that the cross between the Leicester and Shropshire has produced excellent stock. The ewes were good milkers and the lambs were of desirable market type. When these crossbred ewes were mated to a Cheviot, Southdown, Suffolk, or Shropshire, the progeny was superior to the parent stock.

In a later publication (Publication #865, "Breeding for Lamb Production", December, 1951, Department of Agriculture, Ottawa), they state, in reference to crossbreeding sheep at the Central Experimental Farm, Ottawa, that "first cross Border Leicester x Shropshire ewes were compared with straight Shropshire ewes of the same line as that from which the crosses were bred. Over a nine-year period the crossbreds produced fourteen more lambs per hundred ewes, and these lambs were not only heavier at birth but also made more rapid gains. The lambs from the crossbreds reached market weight and finish twenty-four days earlier, and the ewes produced thirty-three per cent more clean wool".

Limitations of crossbreeding

The practice of crossbreeding has some limitations in maintaining a flock. It is known that certain crosses are unsatisfactory as the animals produced therefrom are unsuitable. The ewe flock will lack the uniformity both in size of animals and in breed characteristics of the well "graded-up" flock, and this variation will also be noticeable in the market lambs. This lack of uniformity in general appearance may lower their market value. Under a crossing system, many owners may use crossbred sires of high individual merit in their breeding flock. This practice, of course, would be a mistake since their use would cause a rapid deterioration in the quality and uniformity of the flock.

Registering and identifying purebred sheep

All purebred sheep are registered by the Canadian National Live Stock Records, Ottawa. A pedigree is supplied for each animal on application by the breeder. To be eligible for registration, the sheep must be properly identified and from a registered sire and dam of the same breed. Properly filled application forms must be submitted to the Records Office by the breeder before a pedigree is supplied. Each breeder is required to keep a private record of his breeding operations, and this record shall at all times be open to the inspection of officials of the Canadian Sheep Breeders' Association and the Canadian National Live Stock Records. Lambs must be identified by tattoo or ear tags or both, prior to the first of September of each year. A breeder shall apply to the Canadian National Live Stock Records for, and be allotted, letters for his exclusive use with which to identify sheep lambed on his property. If identifying by tattoo marking, the letters allotted the breeder shall be placed in ear, right or left, as designated by the Canadian Live Stock Records. In addition to the identifying letters, there must also be tattooed in the other ear the flock number of the animal followed by a designating year letter to signify the year of birth. A registration fee is charged for each pedigree supplied. Information in connection with registering stock is supplied by writing the Canadian National Live Stock Records, Department of Agriculture, Ottawa.

Importance of purebred rams

For any class of live stock, the selection of a sire should receive a great deal of attention. From the standpoint of maintaining and improving the quality and the productivity of the flock, the sire contributes as much as the whole of the ewe flock. Because of this fact, the sire should be carefully chosen. He should be an excellent representative of the breed and of high quality ancestry. A registered purebred sire is absolutely necessary for flock improvement. A good purebred sire transmits to his progeny the quality which he possesses more uniformly than does a grade sire. In purchasing a sire do not overlook the type and quality of his ancestors. A poor purebred sire is a bad investment.

Closed Type Sheep Barn

HOUSING AND EQUIPMENT

Sheep do not require elaborate buildings. Their essential requirement is provision of dry accommodation with freedom from draughts. They do not need additional warmth during severe weather because of the natural insulation afforded by their fleeces. However, adequate ventilation is essential to maintain comfortable environmental conditions.

There are in general two types of sheep barns: the closed barn, and the shed or open barn. The closed barn is recommended for the production of breeding stock, or for use in areas where severe winter weather prevails, especially during the lambing season.

The open barn is recommended for feeding and shelter for the average commercial flock and lambs on feed.

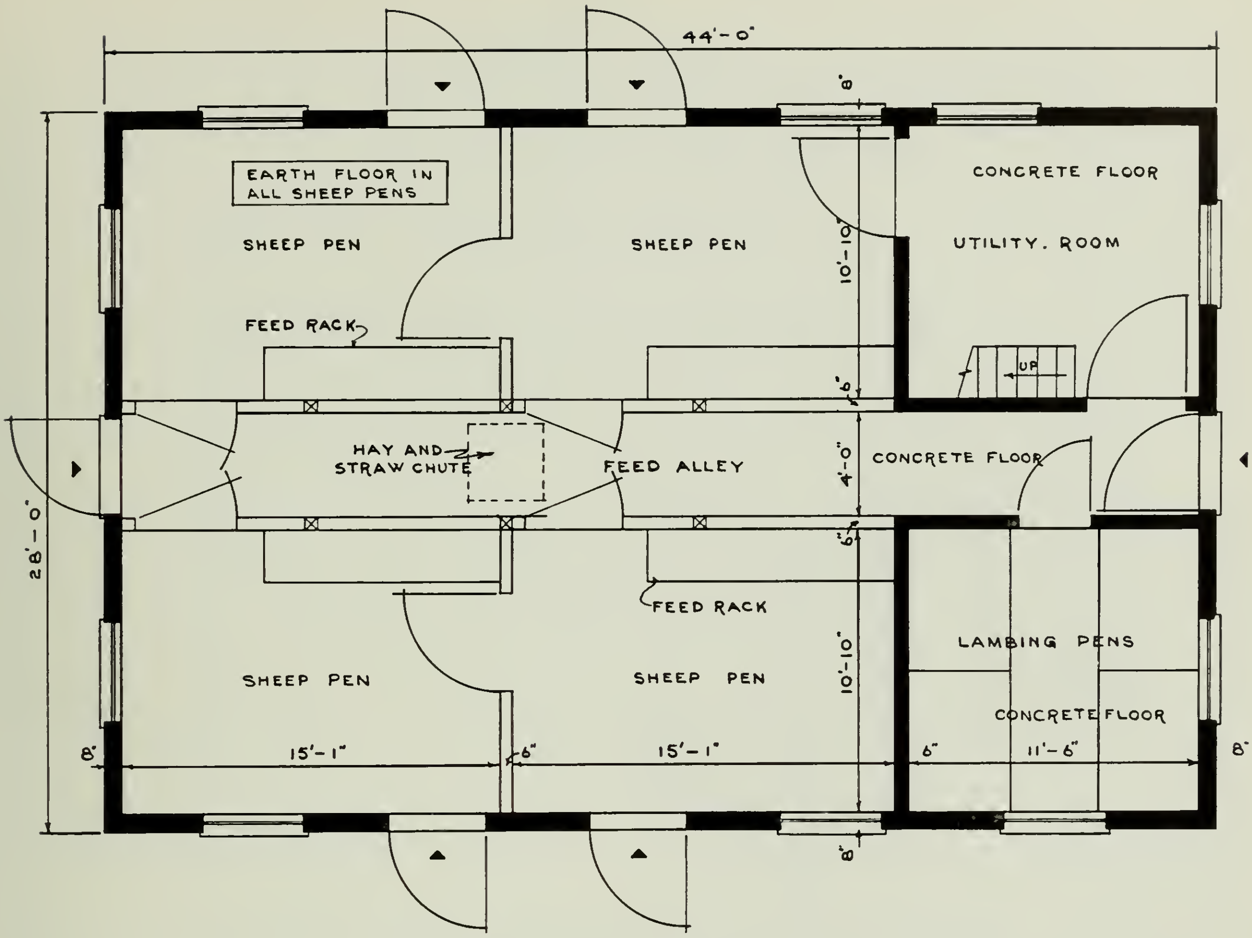
A portable sheep shelter can be used in the early spring to provide shelter for ewes and lambs on cold nights, and in summer to provide shade during the heat of day.

Location of sheep barn

The sheep barn should be built on high, well-drained land with a southern exposure adjacent to open exercise yards. Special caution should be taken to place the structure so that wind does not drift snow into the open front of the shed-type barn. If such a difficulty is encountered, it can be controlled by proper placement of windbreaks. Windbreaks can be either tight, high, board fences, snow fences, or permanent tree plantings of a species that provides protection from the ground up.

The closed barn

The closed barn is usually of two-storey construction with a gable roof. A practical width for such a barn is 28 feet. This width will provide two pens



FLOOR PLAN CLOSED SHEEP BARN

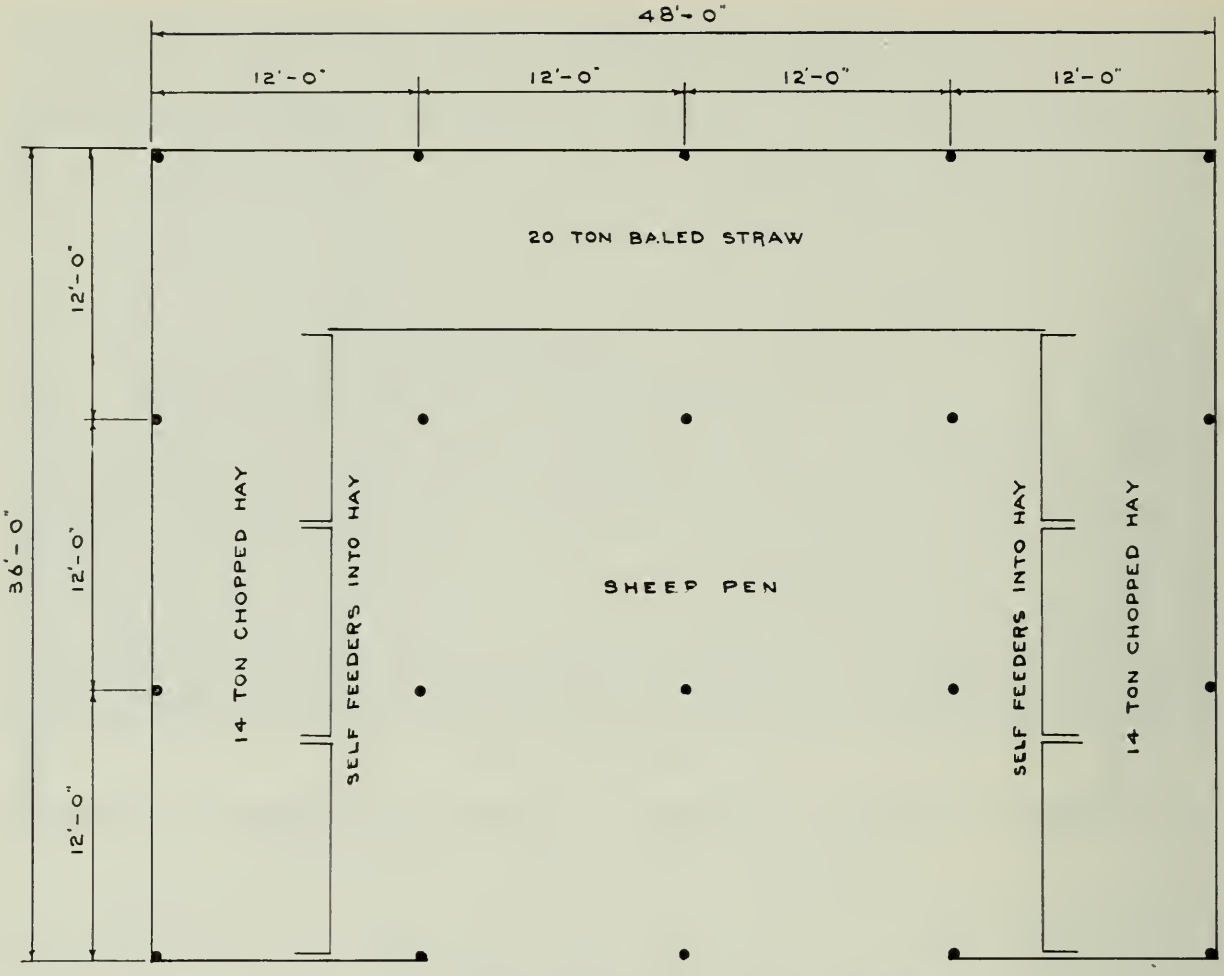
11 feet wide on either side of a 4-foot central feed alley. The loft need not be very large since 4 feet of side wall with a one-third-pitch gable roof will provide ample storage for baled hay and bedding.

To determine the size of barn required for a flock of 30 sheep and more, assuming barn width is 28 feet, an approximate estimate is to allow one foot of barn length for each sheep to be housed. This will provide space for feed room and utility room, in addition to that required for the sheep and roughage storage.

The open barn

The open barn can be constructed of either laminated plank timbers anchored to concrete piers, or of poles set in the ground like fence posts with purlins to support the roof. Either method gives a very good building for a flock of breeding ewes and lambs or for feeder lambs. Its main advantages are its low cost and ease of erection.

The building has wide flexibility from the standpoint of use. Hay can be stored on the ground in one end and bedding in the other. If the building is thirty feet wide and 50 feet long or longer, then hay can be stored at both ends and bedding along the back. Hay is stored on the ground, and the sheep feed through a movable feed manger into the hay. As the hay is fed, more area is provided as winter advances. This is particularly important for ewes since more space is needed after lambing. For some flocks it may be desirable to store the hay in the centre and have a bedded area at both ends. This arrange-



FLOOR PLAN OPEN SHEEP BARN
(FOR 50-60 SHEEP)

ment provides the desirable division required at lambing time when ewes that have lambs are separated from those yet to lamb.

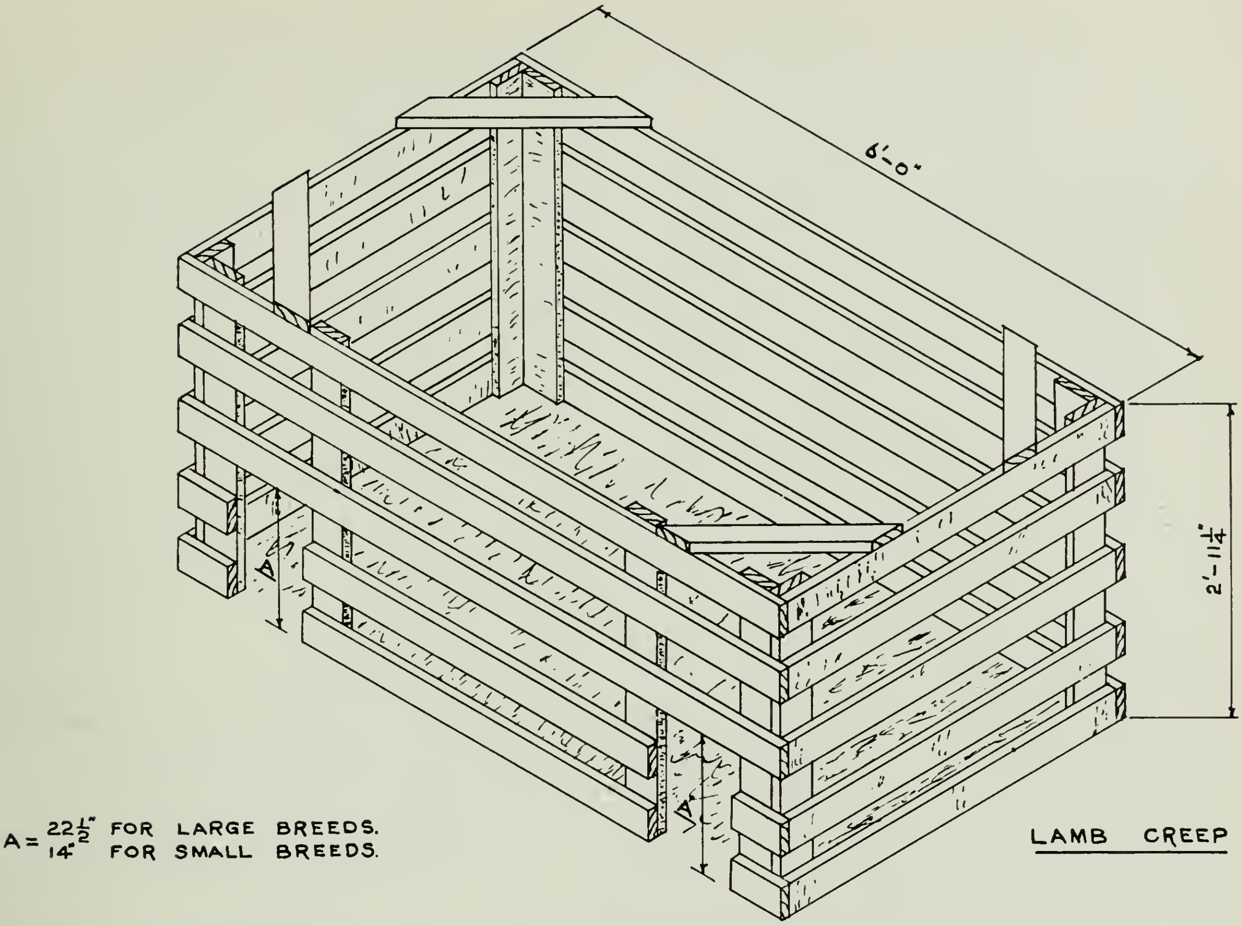
The pole frame construction makes it easy to tie panels to the poles to separate the flock during lambing. With feeder lambs, divisions are often made between different sizes of lambs.

There are no ventilation problems with the open barn, and it is easy to clean with mechanical loading equipment.

Space requirements for sheep

Single pens for ewes at lambing time should be about 4 feet by 4 feet, or 4 feet by 6 feet depending on the breed of sheep. A convenient arrangement is secured by the use of pairs of 4-foot or 6-foot panels hinged together which can be used to divide larger pens. A 12-foot by 12-foot pen can be divided into four or six lambing pens with a 4-foot passageway down the centre. This arrangement will work quite satisfactorily for a flock of upwards to forty breeding ewes. The majority of ewes will lamb in the large pens; however, the individual pens should be used when the weather is extremely cold, and when there is a possibility of ewes disowning their lambs.

After lambing, a combination lamb creep and heat lamp hover will provide additional warmth for the lambs and a secluded space for them to lie down without danger of being stepped on by the ewes.



LAMB CREEP

Table 5—Space Requirements for Sheep in Pens

Animal	Area in Square Feet Small Breeds	Large Breeds
Ewe—mature	12-16	16-20
—3-4 weeks before lambing	15-19	19-23
—with twin lambs	18-22	22-26
Feeder Lambs	5- 7	7- 9
Shearling	7-10	10-14
Ram	14-18	18-24

For computing exercise yard space, these figures should be doubled. To remodel an existing building for a sheep barn, these space requirements should be adhered to, but the general layout of pens and storage room may conform to the shape of the building.

Feed storage space requirements

The following table is based on a daily, winter feeding schedule of 3 lbs. of hay for the entire housing period, 2¼ lbs. of roots or silage discontinued from four weeks before lambing until time of lambing, and ½ lb. of grain.

Table 6—Feed and Bedding Requirements for Sheep

Material	Mature Sheep No. of Feeding Days 180	 210	Flock of 10 Sheep No. of Feeding Days 180	 210	Flock of 50 Sheep No. of Feeding Days 180	 210
Hay	540 lbs.	630 lbs.	2.75 tons	3.15 tons	13.75 tons	15.75 tons
Silage or Roots	300	360	1.50	1.80	7.5	9.0
Grain	90	105	0.45	0.53	2.25	2.65
Straw	240	280	1.20	1.40	6.0	7.0

Table 7– Storage Space Requirement for Feed and Bedding

Material	Approx. Wt. per Cu. Ft. lbs.	Approx. Cu. Ft. per Ton
Hay—Loose	4- 5	400-500
—Baled	14-15	135-145
—Chopped	8	250
SILAGE—Tower silo under 25 ft. depth	30-40	50- 65
—Trench silo well packed	50	40
STRAW—Loose	4	500
—Baled	12	170
SHAVINGS—Baled slightly moist	20	100
GRAINS—Average	39	51
CONCENTRATES—Bran	13	155
—Linseed or soybean meal	30-40	50- 65
—Middlings, loose	25	80
TURNIPS—Average size	40	50

Construction of sheep barn

Light and ventilation—The shed-type sheep barn which is open to the south does not require additional light or ventilation. When the sheep barn is closed on all sides, 1 square foot of window space to every 20 square feet of floor space is recommended. Single-sash windows, hinged at the bottom to open inward at the top, are most satisfactory. For artificial lighting, one 100-watt light-bulb for every 150 square feet of floor space is recommended.

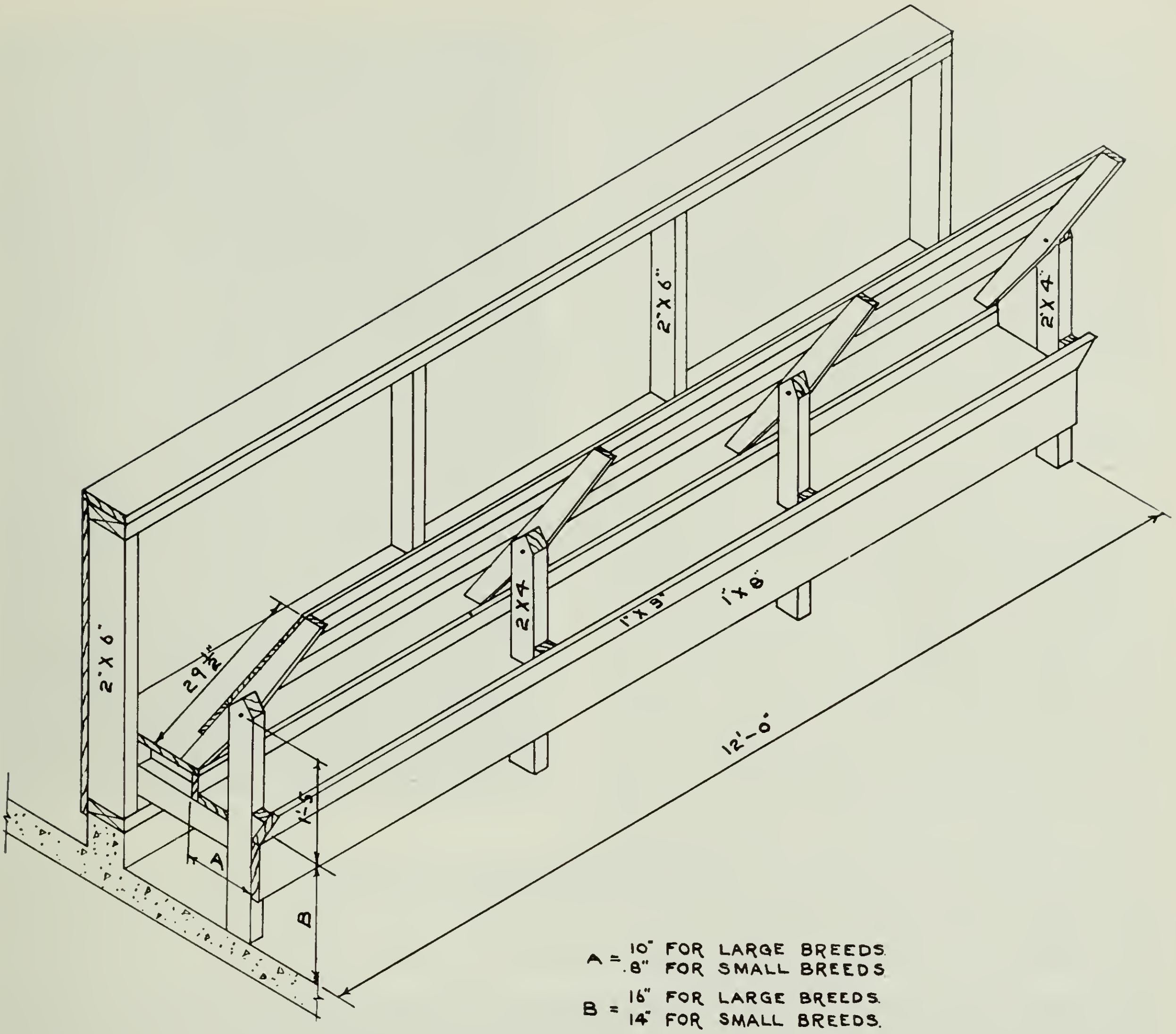
Since sheep are very susceptible to heat, adequate ventilation must be provided in the closed barn. Mechanical or fan ventilation is more reliable than a gravity or flue ventilation system, and the initial cost of the two is about the same. When satisfactory environmental conditions cannot be maintained in the sheep barn by the use of doors and windows, a thermostatically controlled fan with a capacity of ½ to 1 cubic feet of air per minute to every square foot of floor space should be provided.

Floors—In either the closed barn or the open barn, it is common practice to leave a dirt floor in the pens and allow the manure to accumulate. The feed room and passageways should have concrete floors with an 8-inch concrete curb under all partitions. Best results are obtained when the inside of the pens is filled with crushed limestone to a depth of 4 inches above the outside level and then covered with earth, preferably clay. This will ensure a dry floor which is an important consideration since sheep will not thrive on damp floors.

Doors—Large doors should be arranged in the barn so that a manure spreader can be driven through. In addition, doors 10 to 12 feet wide are essential to prevent crowding of sheep. Single doors in pens should be 48 inches wide. The doors can be split into halves so that the upper half can be opened for ventilation.

Walls and Ceiling—Walls can be of simple frame construction in the closed barn, or of poles and vertical sheathing nailed to cross girts in the open barn. Walls need not be insulated if they are of tight construction to prevent draughts.

The ceiling should be a minimum of 8 feet 6 inches in height to permit the use of front-end tractor-mounted manure-loading equipment. If other means of manure removal are to be used in the pens, the ceiling height can be reduced



PERMANENT TYPE FEED RACK

to 7 feet 6 inches. Ceilings or mow floors must be of tight construction, preferably tongue and groove material, to prevent dust and chaff from falling onto the fleece of the sheep.

Feed racks and mineral troughs

Feed racks can be either portable and used as pen dividers, or permanent as used frequently in the closed barn. They should be built to prevent chaff from falling on the backs of sheep. About 12 to 18 inches of trough space per sheep should be allowed to permit all the sheep to feed at one time. Roots, grain, and hay are usually fed in the same trough.

Above is shown a very efficient feed rack which fulfills all the requirements of a good feeder. The rack is of tight construction to confine the chaff. It can be tipped back to permit both the cleaning of the trough and the feeding of roots and grain so that all sheep may feed without crowding.

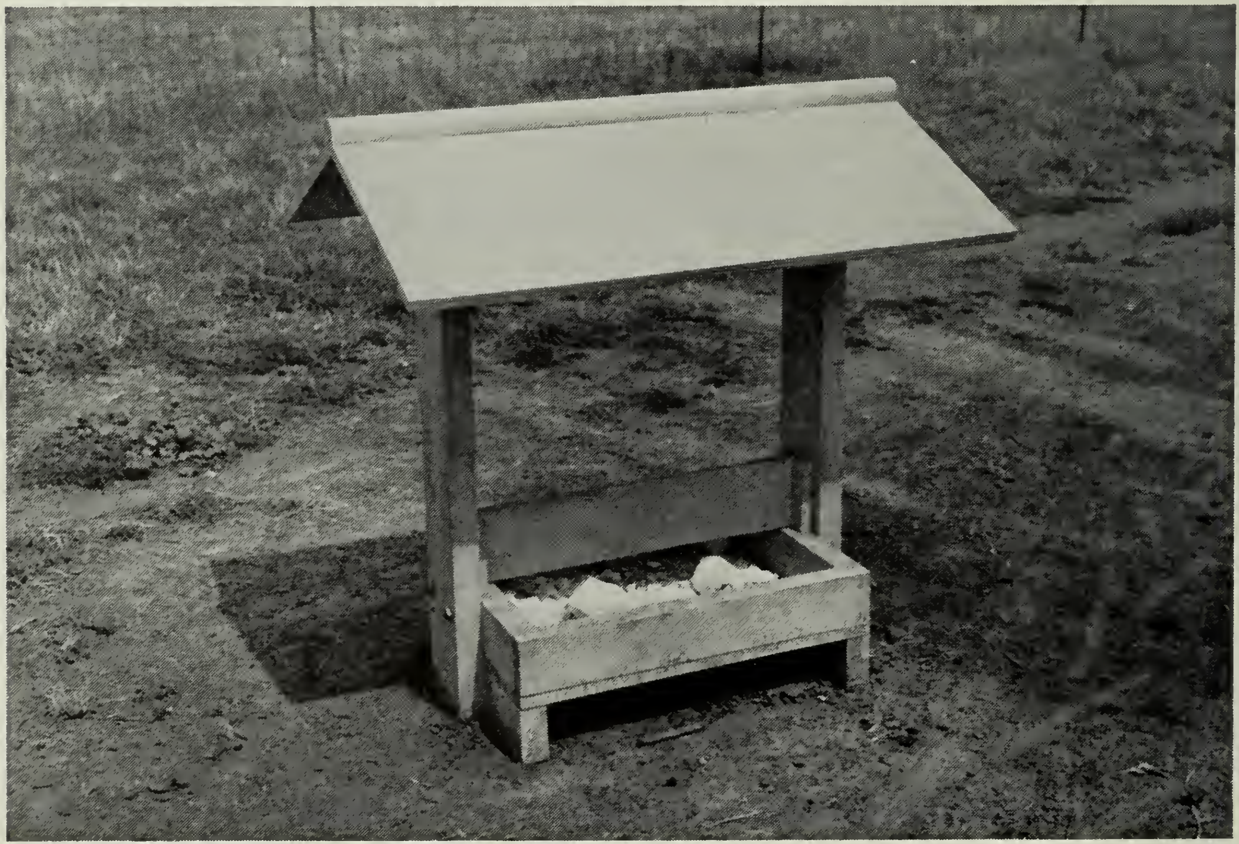
The same construction can be used to build a movable combination roots, grain, and hay rack. This rack can be moved easily, and thus can be used inside or out. It is easily cleaned and, when used as a pen divider, will provide feeding space for each pen.

Sheep must have ready access to minerals at all times. When sheep are confined to pens, a simple corner trough works satisfactorily. When they are out on the range, more elaborate boxes are required. These range boxes must be sturdy to prevent sheep from upsetting them, otherwise they should be securely anchored to a fence post. The box should have a simple roof to protect the contents from the weather.

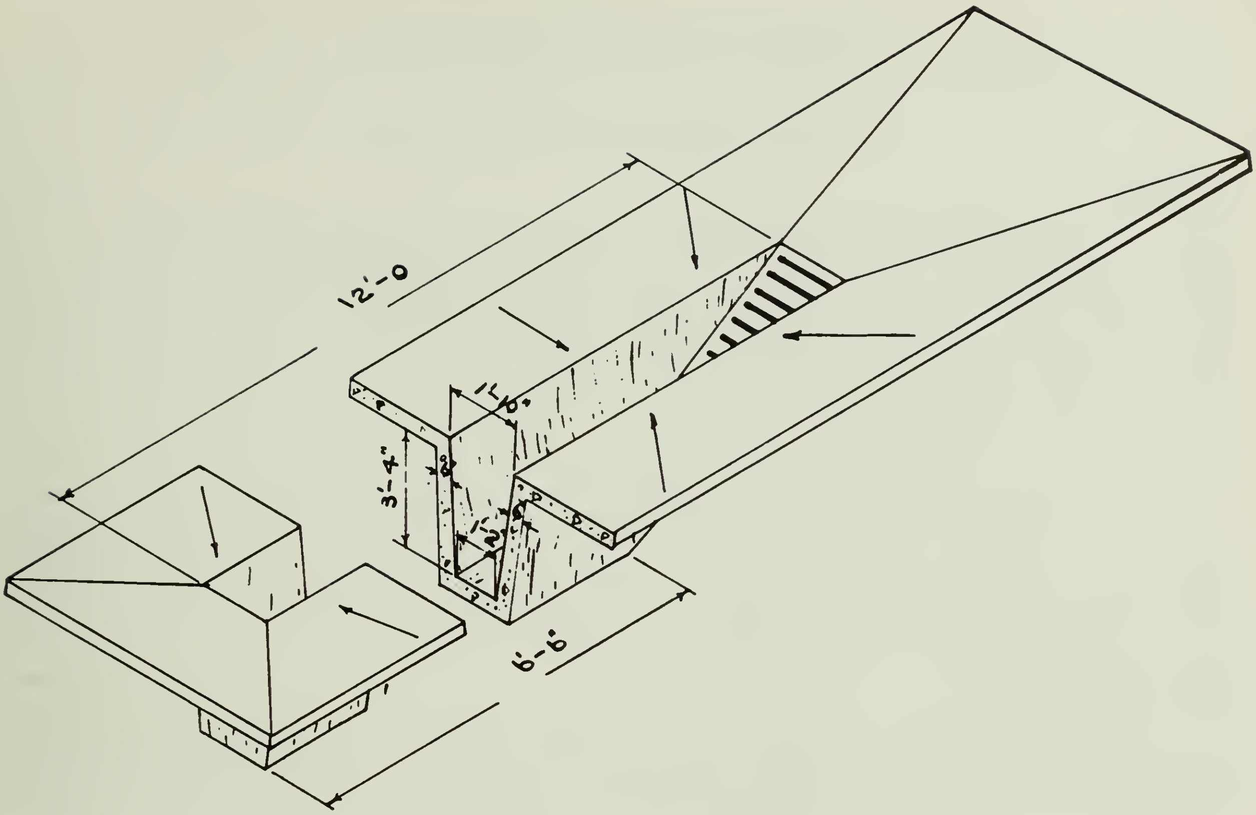
Utility room

A shepherd's or utility room which can be conveniently divided or partitioned into pens by swinging gates should be provided. This room, can be used for a variety of purposes: (1) as space for lambing pens; (2) as a fitting room for show stock; (3) as a shearing and docking room; (4) as a hospital room, should it become necessary to isolate sick animals, and (5) as a dipping room. If used as a dipping room, the dipping tank should be constructed below floor level and along one side of the room. The floor should be sloped to drain into the tank, and suitable drainage must be provided to remove the solution from the bottom of the tank. Sheep should enter the tank from a central passageway

A Feed Rack



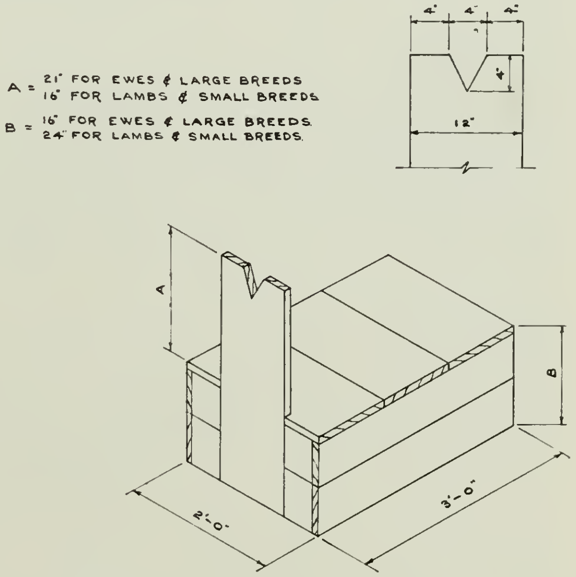
A Mineral Box



SHEEP DIPPING TANK

and, after being dipped, they should be held on the sloping floor to allow the excess solution to drain onto the floor and back into the tank. An additional door is required in the utility room so that dipped sheep can be herded into the other end of the building. When not in use, the tank can be covered over at floor level with hinged covers.

The utility room should be adjacent to the feed storage and centrally located for efficient handling of sheep. Supplemental heat can be provided in this room during the lambing season if the room is lined with a fireproof wallboard. Medicinal supplies should be enclosed in a wall-mounted cabinet in the utility room. The size of the room will depend to a large extent on the size of the flock. An average size would be 14 feet by 20 feet.


A = 21" FOR EWES & LARGE BREEDS
16" FOR LAMBS & SMALL BREEDS
B = 16" FOR EWES & LARGE BREEDS.
24" FOR LAMBS & SMALL BREEDS.
4"
4"
4"
4"
12"
A
B
2'-0"
3'-0"

TRIMMING STAND

FEEDS AND FEEDING

CHARACTERISTICS OF FEEDS

Roughages

Good, high-quality roughages, including high-quality pasture throughout the growing season, form the basis of the sheep feeding program. Legume hay or a good quality mixed hay containing a high percentage of legumes will prove most satisfactory. Succulent feeds, such as silages and roots, have a definite place in the sheep ration but are not indispensable.

Alfalfa

Alfalfa is an excellent roughage feed. If properly cured, it is a good source of protein, calcium and carotene. It is only fair in phosphorous content. In Ontario, alfalfa is usually grown as part of a legume-grass mixture. Providing alfalfa constitutes about one-third to one-half of the mixed hay, the advantages from the feeding of alfalfa will be gained.

Red Clover

Red clover hay or mixed hay composed chiefly of clovers will give results almost equal to those obtained with alfalfa. The quality of mixed hay containing red clover is improved by medium-early cutting.

Brome Grass

Brome grass is frequently used in legume-grass mixtures for both pasture and hay. It retains its palatability throughout the growing season. Like all grasses, brome falls off rapidly in protein content after heading out. Rapidly growing grasses, as found in a properly managed pasture, are high in protein. However, as a hay, brome grass supplies only one-half the protein and one-seventh the calcium provided in average-quality alfalfa hay.

Timothy

Early-cut timothy hay can be used for sheep feeding, but it is more valuable in a legume-grass mixture. Late-cut timothy is not a satisfactory feed for sheep.

Corn Silage

Good-quality corn silage is an excellent, succulent roughage for the winter feeding of sheep. The value of corn silage when fed as part of a balanced ration is approximately half that of good-quality hay. While a useful feed, silage is not an essential because of the relatively small amount which should be fed to sheep (1 to 4 pounds daily), and it is often not practical to include silage in the feeding program.

Grass Silage

Good results have been obtained from the feeding of grass silage as a large part of the ration of pregnant ewes. The fact that grass silage is higher in protein and lower in available energy than corn silage should be considered in formulating the ration. For fattening lambs, care should be taken to provide extra energy in the form of grain. It is doubtful if grass silage possesses any advantages over properly cured hay for sheep feeding. Good grass silage is a dependable source of carotene or provitamin A. This is a distinct advantage if the sheep flock must use lower-quality roughages with a low carotene content. Both corn silage and grass silage, if of good quality, are palatable. Frozen silage should be avoided, and mouldy silage should never be fed, and no silage should be fed during the month previous to lambing.

Roots

Roots, especially turnips, are an excellent succulent feed for sheep. They are usually fed when silage is not available. Roots have about two-thirds of the feeding value of corn silage when fed to either pregnant ewes or fattening lambs. While as much as 15 to 20 pounds of roots may be fed, the amount is usually restricted to two to three pounds per head daily. The dry matter of roots is of high digestibility, but the fact that they are low in protein and minerals should be taken into account in formulating rations containing roots. Because of the labour involved, the cost of growing roots is high.

Other Roughages

While the above dry and succulent roughages are the principal ones used in Ontario, other feeds may be fed. Sheep require a higher protein roughage than beef cattle and, for this reason, straight grass or cereal hays have not proven too satisfactory for wintering ewes. If grass hays must be used, they will require supplementation with protein-rich concentrates such as linseed oil meal. Feeds such as pea vine silage, sometimes available in cash crop areas, may be satisfactorily used as a part of the feeding program.

PASTURES

Permanent Pasture

Profitable sheep production is based upon the efficient utilization of high-quality roughages. During the growing season, the use of good pasture supplies these roughages more economically than any other method. The value of a pasture for sheep depends upon two main factors: (1) The composition of the pasture mixture and the fertility of the soil, (2) the system of grazing and management followed. Under Ontario conditions, a mixture of grasses and legumes will prove more satisfactory than either grown separately. The inclusion of the more palatable species of grasses will reduce the tendency to bloat which is often encountered with straight legume pastures, and will provide more uniform grazing throughout the season. Improved pastures should be kept in a leafy, vigorous condition by proper stocking, clipping if necessary, and fertilization. In Australia and New Zealand, sheep and cattle graze pastures in alternate periods. The advisability of the more general adoption of this management practice is indicated by the results of studies recently conducted at Ottawa. Because of the different grazing habits of the two classes of stock, they utilize the pasture more efficiently than either alone.

Too frequently, sheep are expected to subsist on poor, unimproved pasture. Sheep are excellent converters of grass to meat and wool, and will repay expenditures on reseeding and fertilization. Pasture improvement programs should aim at increasing the grass cover, the percentage of legumes in the mixture, and the nutritive value of the herbage.

Temporary or Annual Pasture

The use of such crops as fall rye, oats, and rape allows for a longer pasture season and a more uniform supply of feed throughout an extended pasture season.

Fall rye makes possible early spring grazing which is particularly important with ewes nursing lambs. Oats, oats and peas, or oats and sweet clover, if pastured just before the oats come into head, will provide excellent supplementary feed for early midsummer.

Rape is widely used as a supplement to permanent pasture. Under favourable conditions of soil and moisture, heavy yields of pasture approaching alfalfa and red clover in feeding value can be obtained. Rape may be pastured after the crop is six to eight inches high. If not too heavily grazed, rape may be used to extend the pasture season into the fall, since the plants remain palatable after early frosts.

Marrow-stem kale can be satisfactorily grown in Ontario and is useful as a sheep feed. At present, its use is limited.

Temporary pastures serve as an excellent supplement to permanent pastures and even out the production of forage throughout the pasture season. This makes possible the carrying of a large flock of sheep on a given area. Temporary pastures allow for the rotation of land being used by sheep, thus aiding in parasite control.

CONCENTRATES

Oats

Oats may be used extensively for the breeding flock, for young lambs, and for starting lambs on feed. It is unnecessary to grind oats for sheep. Rolling may improve palatability, but grinding may actually lower feeding value.

Oats vary markedly in feeding value according to the percentage of hull. They are worth approximately 5% less than barley as a single grain for fattening lambs, or 2% less if the oats replace barley in a grain mixture. On the average, oats give about 5% less gain and are 8% less efficient than corn as a fattening grain. They are slightly less efficient than wheat for fattening. Fattening lambs may be placed on full feed more quickly with oats than with heavier grains. Providing the oats are of good quality and are full fed, they may be used as the sole grain for fattening. Lambs full fed on oats will consume more grain and less roughage than if heavier grains are used.

Barley

Barley is a very satisfactory grain in mixtures for fattening lambs and for breeding ewes. As a fattening feed, the value of barley is approximately 5% less than corn and 3% less than wheat. In view of these small differences, the decision as to which grain to use will often depend upon other factors such as quality of the sample and availability. Barley should be rolled, but not ground, for sheep.

Corn

Where corn is grown extensively, it is the standard grain for fattening sheep. With the advent of hybrids, corn is being more generally grown in Ontario, and frequently is the cheapest source of energy-rich feeds available. Corn grain is usually fed to sheep in the form of shelled corn or as ear corn. If ground corn is used, care should be taken to avoid too fine grinding.

Corn is lower in protein than oats, barley, or wheat. Legume hay will make good the deficiency of protein. If a protein-rich roughage is not available, linseed oil meal should be used as a protein supplement. If corn is fed to the ewe flock, care must be taken to guard against overfatness.

Wheat

Wheat is used only to a limited extent in the feeding of sheep. It is the highest in protein of the cereal grains, but is usually not competitive in price. As the only grain fed to fattening lambs, wheat has given somewhat better results than barley and poorer results than corn. Wheat is best fed as part of a mixture and, for best results, should be fed unground. With a mixture there is less danger of lambs going off feed.

Wheat Bran

Wheat bran is relatively bulky for a concentrate and is higher in protein and phosphorous than farm grains. Because of its bulk and its tendency to promote a slightly laxative condition, wheat bran is used when bulk is of value in the ration. It is particularly useful as part of the grain mix for breeding ewes and for lambs starting on a fattening ration. If reasonable in price relative to grain, wheat bran may constitute 10% to 15% of the finishing ration when the heavier grains are used.

Linseed Oil Meal

Linseed oil meal is the standard with which other protein supplements are compared. If non-legume hay and corn silage are used, it is often necessary to add additional protein to the grain mix, and linseed oil meal (35% to 37% protein) is often used in such cases. It is higher in phosphorous than farm grains.

Soybean Oil Meal

Soybean oil meal (protein 44% to 47%) is being more widely used as a protein supplement in sheep rations. Linseed oil meal and soybean oil meal have been shown to be interchangeable in sheep rations. If available, soybeans (unground) may replace soybean oil meal in feeding sheep.

Cane Molasses

Molasses has its highest value in a fattening ration **providing not more than one-third to one-half of a pound is fed daily.** If low-quality roughage must be fed, molasses will increase its palatability. The value of molasses when added to a palatable grain mix is, pound for pound, somewhat less than grain.

Urea

Urea, as sold, contains approximately 40% nitrogen and is, therefore, a nitrogen-rich feedstuff. The bacteria of the rumen are able to convert this nitrogen into protein which is, in turn, utilized by the sheep. The protein content of a feedstuff is usually reported as a percentage of nitrogen X 6.25, such as is illustrated in the following table:

Feedstuff	% Nitrogen	% Protein (N x 6.25)
Oats	1.92	12.0
Corn	1.38	8.6
Linseed Oil Meal	5.60	35.0
Soybean Oil Meal	7.26	45.4
Alfalfa Hay	2.37	14.8
Timothy Hay	1.04	6.5

In these feedstuffs, the nitrogen is present largely as preformed protein. In urea, the nitrogen is of a different form, but when transformed to protein material in the rumen, it can, within limits, replace the protein in the ration. If price relationships are favourable, a mixture of 90% grain plus 10% urea may replace linseed oil meal, providing that not more than one-quarter of the protein in the final grain mix is derived from urea. The following combinations would give a 14% protein grain mixture:

Oats and barley	920 lbs.
Linseed oil meal	80 ”

or

Oats and barley	956 lbs.
Linseed oil meal	40 ”
Urea	4 ”

or

Oats and barley	922 lbs.
Urea	8 ”

MINERAL FEEDS

Salt (Cobaltized-Iodized)

Sheep consume considerably more salt per 100 lbs. of live weight than cattle. Sheep also have a higher requirement for cobalt. They will consume from one-fourth to one-half of an ounce of salt a day. In Ontario, the use of commercially available cobaltized-iodized salt will provide an “insurance” against cobalt and iodine deficiency in border-line areas. Such mineralized salt is more expensive than iodized salt, so perhaps its use should be restricted to the breeding flock. Iodized salt may be fed to fattening lambs.

Bonemeal (a source of calcium and phosphorous)

Under certain conditions, carriers of calcium and phosphorous should be added to the sheep ration to increase the percentage of these two minerals. Steamed bonemeal or feeding bonemeal (calcium 23%, phosphorous 11%) is the standard calcium-phosphorous supplement in live stock feeding. Bonemeal also contains significant amounts of the trace elements.

Limestone (Source of Calcium)

Ground limestone (38% calcium) is the cheapest form in which calcium is available. However, if a legume or legume-grass roughage is used, the regular feedstuffs will provide sufficient calcium.

Monocalcium Phosphate, Dicalcium Phosphate and Disodium Phosphate (Sources of Calcium and/or Phosphorus)

The mono- and dicalcium phosphates supply both calcium and phosphorus. Disodium phosphate supplies phosphorus only. The mono- and dicalcium phosphates, when available, are more concentrated sources of phosphorus than the other regularly used phosphate sources.

Other Phosphorus Carriers

A number of the colloidal clay products and defluorinated phosphate products available are valuable, providing they do not contain too high a percentage of fluorine. The level of fluorine in the grain ration of sheep should not exceed 1/100 of 1%. As a long range program, it is advisable to meet the sheep's requirements for calcium and phosphorus through the use of legume-grass mixtures grown on well-fertilized land. The use of the recommended levels of fertilizer will increase both the yield and mineral content of the forage. Such forage will meet the animals' needs for calcium and phosphorus. There have been no demonstrated benefits from the use of complex mineral mixtures.

Rations and Amounts

Feeding standards which indicate the amounts of the most important nutrients needed have been developed. The following rations, if fed as recommended, will meet the requirements of the various classes of sheep. Amounts fed in excess of the recommendations will represent over-feeding or will be refused. Under-feeding will result in poor performance and will prove uneconomical.

The Breeding Ram

The young ram should be fed a balanced ration to aid in body development. The mature breeding ram should be maintained in a thrifty and vigorous, but not high, condition. Good pasture in summer and high-quality roughage in winter, except during the breeding season, will be satisfactory. Two weeks to a month before the breeding season commences, and continuing throughout this season, the ram should be given one pound daily of grain mixture in addition to a good-quality roughage. Any of the grain mixtures recommended for ewes will be satisfactory.

The Dry Ewe (approximately 140 pounds weight)

—Up to 4 to 6 weeks before lambing

A	Good quality legume hay	4 - 5	lbs.
	or		
B	Equal parts legume-grass hay	4 - 5	lbs.
	or		
C	Legume hay	2½-3½	”
	Corn silage	2½-3½	”
	or		
D	Legume hay	3 - 4	”
	Roots	2 - 3	”
	or		
E	Early-cut grass hay	2½-3½	”
	Corn silage	2 - 3	”
	Linseed oil meal	¼	oz.
	Ground limestone	¼	oz.

—Last 4 to 6 weeks before lambing

Roughage as in A or B plus ½ lb. of a grain mixture such as is suggested below.

The Nursing Ewe (approximately 140 lbs. weight)

—Not on pasture

Any of the roughage rations mentioned above plus 1 to 1¼ lbs. of grain. The amount and percentage of protein in the grain mixture depends upon—

1. The quality of the roughage;
2. The age and size of the lambs;
3. The condition of the ewes.

Suggested grain mixtures for pregnant and nursing ewes are as follows:

If at least one-half of the roughage is a legume

Oats	67 lbs.
Wheat bran	33 ”

or

Oats	60 ”
Corn and cob meal	30 ”
Linseed oil meal	10 ”

or

Barley or corn	50 ”
Oats	20 ”
Wheat bran	20 ”
Linseed oil meal	10 ”

or

A good dairy mixture containing 12% to 14% protein.

If only a small part or none of the roughage is legume

Oats	60 lbs.
Wheat bran	25 ”
Linseed oil meal	15 ”

or

Barley or corn	30 ”
Oats	20 ”
Wheat bran	30 ”
Linseed oil meal	20 ”

or

A good dairy mixture containing 16% to 18% protein.

Grain should be removed from the ration before lambing and reintroduced slowly to prevent the production of more milk than the lambs can handle at this stage. The grain allowance per ewe should be about 1 pound per day by the time the lambs are ten days of age.

Ewes and lambs should be placed on pasture as early as possible because good pasture is the cheapest source of feed that can be used. Only if ewes are thin or if high weight gains are expected will supplementary grain feeding be necessary.

Creep Feeding Lambs

If early or extra gain is desired in anticipation of a more profitable market, lambs may be provided with a supplementary creep feed. Lambs will take both hay and grain in a creep beginning when they are two weeks old. Such grain should be rolled or coarsely ground. When lambs are six weeks of age, the grain need not be ground.

Creep feeding of lambs is recommended, lambs so fed and managed making greater growth and being ready for market at an earlier age.

Fattening Lambs

To obtain rapid and efficient gains in feeder lambs, the ration should be based upon high-quality roughage and a fairly liberal grain allowance. Good feeder lambs averaging approximately 65 pounds at the start of the feeding period should gain from ¼ to 1/3 pound daily over a feeding period of 85 to

115 days. This will result in approximately 30 pounds gain, and allow the marketing of finished lambs at an average weight of 95 pounds.

At the start of the feeding period, lambs should have access to a mixed legume-grass hay. At first, the grain allowance should be moderate (1/10 to 2/10 pounds per head daily). The amount fed may be increased steadily until the lambs are receiving 1 to 1¼ pounds daily. Care should be taken to avoid the feeding of spoiled feeds. Over-feeding will cause digestive upsets and result in lambs doing poorly. An 80-pound lamb on full feed will consume the following amounts of feed:

Legume hay	1½ lbs.
Barley, oats, or wheat	1½ ”
or	
Mixed legume-grass hay	1½ lbs.
Corn	1½ ”
Linseed oil meal	1/10 lb.
or	
Legume hay	¾ lb.
Corn silage	1¾ lbs.
Grain	1½ ”

If young, thrifty, lighter lambs are available, they can be satisfactorily finished by the use of more roughage and somewhat less grain. The use of at least one pound of grain per head daily during the last half of the fattening period is recommended if a satisfactory finish is essential. Heavier feeder lambs should be brought to full feed quickly and given a higher grain allowance than lighter lambs if the desired finish is to be obtained.

Sheep of all ages should have ready access to loose cobaltized-iodized salt and to fresh water.

MANAGEMENT OF THE FLOCK

Profits in sheep production depend, to a large extent, upon the size and quality of the lamb crop. Such being the case it is important that all steps essential to the production of a strong, healthy and large lamb crop be given primary consideration by the flock owner or manager.

Preparation of the ewes for Breeding

The first factor in producing a large crop of strong lambs is to have ewes healthy and gaining in condition at the time of breeding. This preparatory process is frequently referred to as "flushing". Ewes, particularly if they are thin following the weaning and sale of the lambs, should be placed on a good pasture of rape or aftermath grass two to three weeks before breeding or, preferably, given access to both rape and grass. Rape, seeded at the rate of 5 to 8 lbs. per acre approximately six to eight weeks previous to time pasture is required, will produce excellent feed for the breeding flock. Ewe lambs should not be bred unless they are well grown and weigh at least 110 lbs. at breeding time.

Time to Breed

The time for turning a ram with the ewes will depend upon when the owner wishes the lambs to be dropped. Buildings, equipment, market requirements, and care available at lambing time must be considered in arriving at a decision. The average gestation period for sheep is 150 days. If March lambs are preferred, the ram must be turned with the breeding flock in October, and if April lambs are wanted, the ewes should be mated in November.

More personal attention by the flock owner is required for successful production of early lambs. The owner, if operating a mixed farming business, usually has more time available for care of the flock early in the spring before field work starts. Early market lambs invariably sell at a higher price, while pure bred lambs must be well grown and developed if they are to command a profitable outlet. However, if buildings and equipment are not adequate to provide protection for the lambs and ewes against the extreme weather which may occur early in the spring, breeding should be delayed so that lambs will arrive when such protection is not required. Before turning the ram with the flock, the owner should trim the wool from about the eyes of heavily wooled sheep, and from around the breech and tail or dock. The feet should also be trimmed.

Care of the ram at breeding time

The ram should be in good, healthy condition, but not overfat or paunchy at breeding time. Normal heat periods in ewes of most breeds begin with the first cool nights in September. Therefore the ram must be separated from the flock before that time, otherwise lambs will arrive in the winter when the risk of loss is great. If confined to a pen, the ram should be fed good legume hay, a light grain ration, water, and salt, and permitted out for exercise every day. If on pasture, about one pound of grain per day plus water and salt will serve to keep him in good condition. His feet should be examined and any excess hoof growth which might interfere with normal activity removed.

Breeding Practices

The method of breeding will depend upon the number of ewes to be bred and the age and vigour of the ram. Where flock breeding is practiced, that is when the ram is turned out with the ewe flock, a well-grown, vigorous yearling or aged ram will breed 40 to 50 ewes per season; a ram lamb 15 to 25 ewes per season. To conserve the usefulness of the ram as a breeder, semi-flock breeding may be practiced. When this system is followed, the ram may be separated from the ewes for about 12 hours of each 24, or turned out with the flock at night and confined during the daytime. Hand breeding can be practised in the mating of valuable purebred individuals, or when it is desirable to extend the services of a ram over much larger flocks. Hand breeding involves bringing the ewe which is observed to be in heat to the ram for breeding, and then returning her to the flock after she has been bred. Flock breeding is the common practice in commercial flocks of Ontario.

Checking of Fertility of Ram

In order to check the fertility of a ram, his brisket and chest should be dusted with yellow ochre (not house paint) before he is turned with the flock. If this dusting process is repeated every two or three days a breeding record may be kept by noting the ewes marked each day. In view of the fact that ewes come in heat at 16 to 18 day intervals the colour of the ram marker should be changed to red after that period of time has elapsed. If many of the ewes are then being marked red, it would be advisable to change the ram.

However if the percentage is small the ram may be retained. After the second sixteen-day period, the colour marking can be changed to black. If many ewes return to service, that is, are marked with black, the ram should definitely be changed, since it is obvious that he is infertile. A new ram should be secured and the same procedure repeated. Even a late lamb crop is better than none at all.

Following the breeding season the ram should be separated from the flock, particularly when the ewes become heavy with lamb.

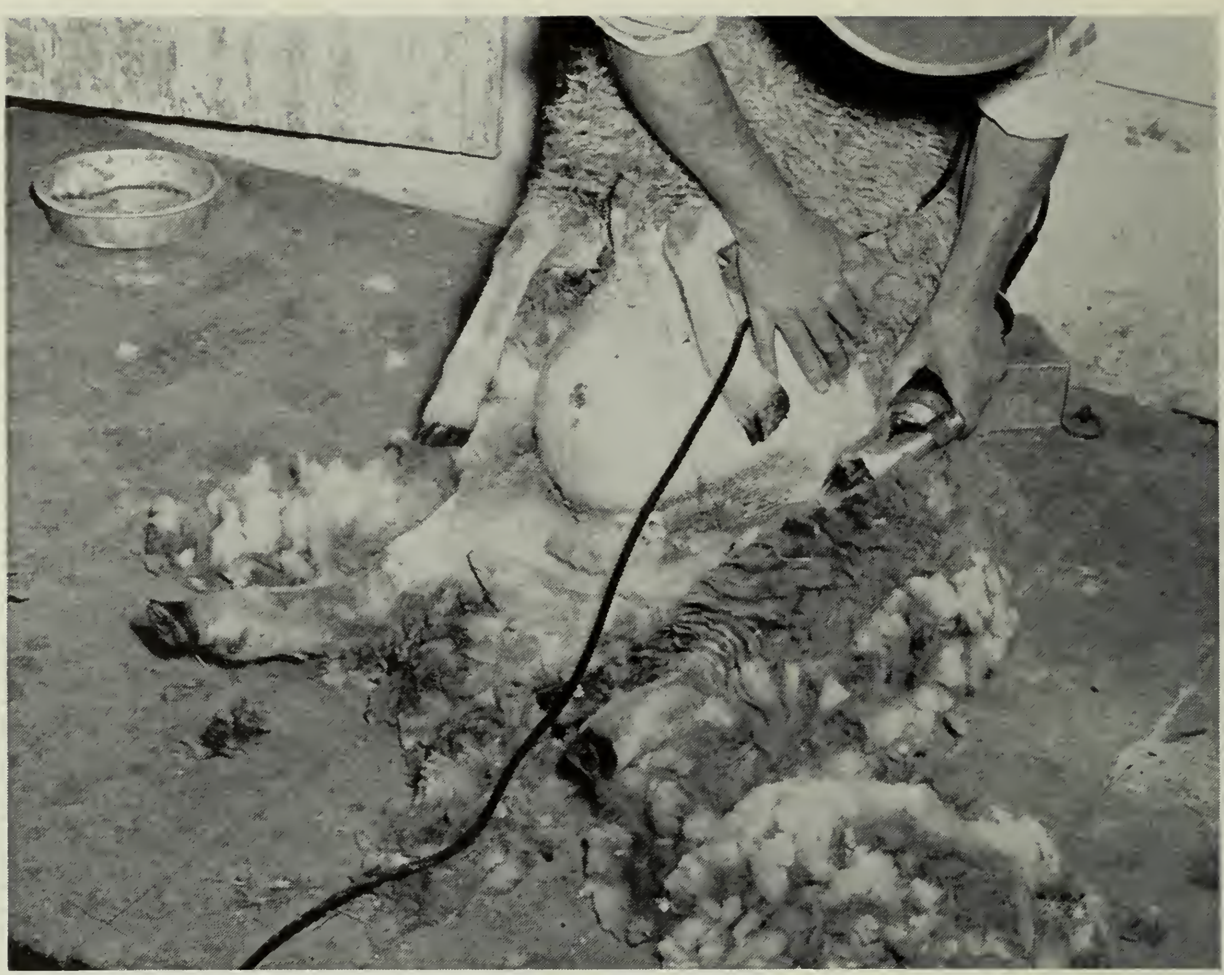
Handling the Bred Ewes

Good-quality legume or mixed, early-cut hay, water, and a mineral mixture including salt will provide adequate nourishment for the pregnant ewes until about five to six weeks before lambing. Then a grain ration should be added as outlined in the section on feeding. Corn or grass silage free of mould, or roots may be fed during the winter months, but should be discontinued about one month before lambs are expected to arrive. Excessive feeding of these succulent roughages will result in overdeveloped lambs of low vitality.

The bred ewes should have adequate housing for protection from rain, snow, and severe cold winds. Well-ventilated, dry quarters are essential, and the flock should be encouraged to take plenty of exercise. This may be accomplished by placing a portion of each day's hay on the ground or snow some distance from the pen. The ewes will then get exercise in the open as they go to and from their feed. If the feed is of good quality, there will be very little loss on the ground.

Wool Care

In order to keep the wool clean, hay for feeding or bedding should never be carried above or shaken over the backs or heads of the sheep. It is preferable to place the feed in racks or on the ground while the sheep are in other quarters. Dust, chaff, and seeds in the wool greatly decrease its value. Precautions taken



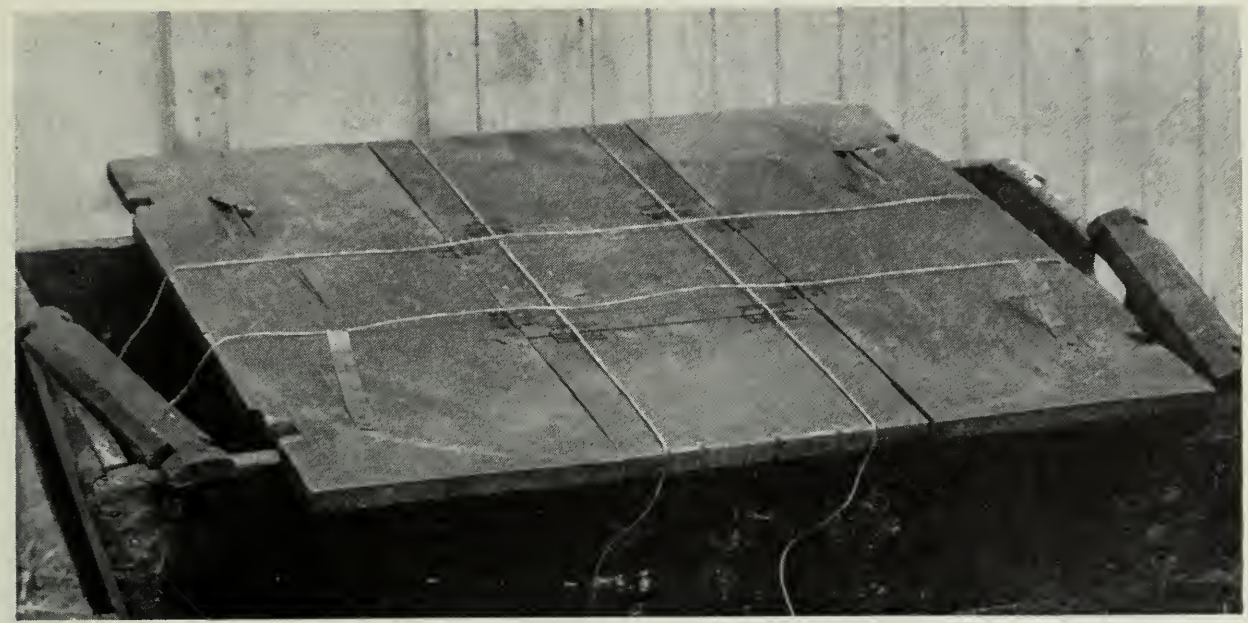
to keep the fleece free from foreign material will pay dividends. Hence all burrs and sticky weeds should be removed from fence corners before sheep are turned into a fresh pasture field or paddock. This is just another precaution to ensure clean fleeces and maximum returns.

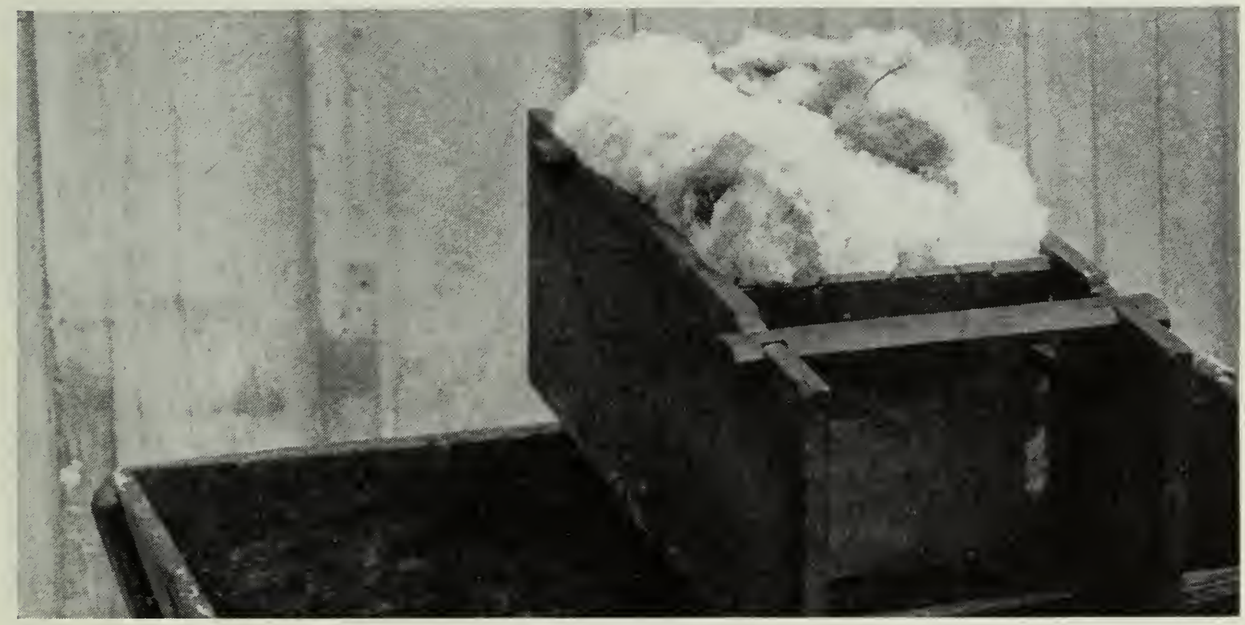
Shearing

Under Ontario climatic conditions, shearing is usually done late in April or early in May. When lambing takes place in March or April—shearing should be delayed until the ewes have lambed in order to reduce the risk of injury to the ewes. If, on account of late lambing, it becomes necessary to shear before the ewes have lambed, care must be taken in handling the ewes, particularly those heavy with lamb, to avoid abortions or abnormal presentations. Motor or hand-powered clippers are frequently used for shearing. Some trained shepherds continue to use hand shears and do a fast, clean job.

How to Shear Sheep

Skill in shearing can be acquired only with practice. This operation should not be undertaken when the wool is damp from rain or heavy dew. It is advisable to enclose the sheep to be shorn in clean quarters, preferably a yard or paddock, while the shearing should be done on a clean floor or grassy sod. During shearing the sheep should be set on its rear quarters with the back between and against the operator's knees. The left hand of the operator is used to control the head and neck, while the right hand is free to handle the clippers. First, the clippers are used to open down the neck, between the front legs, and

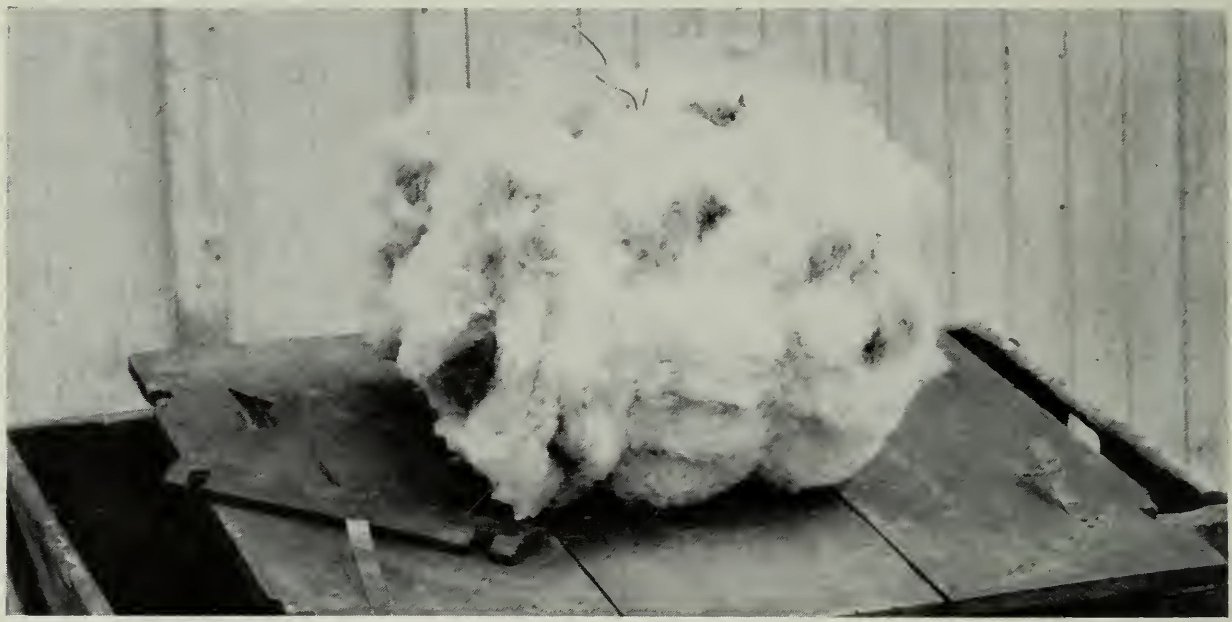

Wool Box Ready for the Fleece


Tying the Fleece

down the middle of the abdomen to the rear flanks. Then the wool is removed from the head and neck and finally from the body. This latter operation is accomplished by directing the clippers from the mid-abdominal region, around each side to the back in long, even strokes. The wool should never be pulled with the left hand while clipping is in progress as this is likely to produce skin cuts at the points where tension is exerted. However, if the left hand is used to draw the skin firm at the point being clipped, a cleaner and closer job of shearing will result. Any wool not removed with the first cut of the clippers is of little value.

In view of the fact that a sheep can be controlled quite easily while set on its rump, it should be kept in that position throughout most of the shearing operation. However the position must be altered when the areas around the rump and tail head are shorn. At this point in the proceedings a sheep will usually try to break away; hence care must be exercised lest she pull the fleece apart during the struggle.

When the fleece has finally been removed it should be spread out on a clean table or grass with the side which was next to the sheep down. All tag locks from the rear of the fleece and the hairy or coarse wool from the legs should be removed and placed in a separate container. The fleece is then ready for bundling. During this process each side is folded in towards the centre until a strip 16 inches wide and the length of the fleece results. This strip should be rolled into a bundle, with the operator always starting to roll from the rear part of the fleece. Following this procedure the best quality of wool, that is the portion located in the fore end of the fleece, will form the outside of the bundle.



The Fleece Properly Tied

The bundle should be tied with a specially prepared paper twine which dissolves during processing. Binder twine and other types of twine or cord must never be used because they cannot be easily separated from the wool. A folding box of the type illustrated will prove helpful in preparing attractively shaped bundles. When each fleece has been bundled and tied it should be placed in a special wool sack or a large bag that is free from chaff seeds or other foreign material.

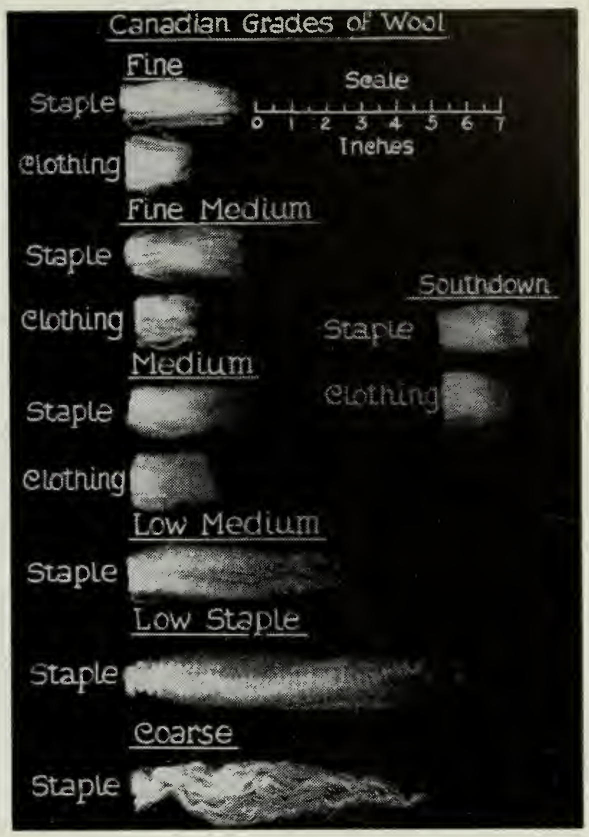
As a general rule shearing can be done more easily during the warm weather. The oil or grease content of the fleece is higher, with the result that the clippers slide more smoothly through the fleece.

At the time of shearing, the feet of each sheep should be examined and any excess hoof growth removed. The udders should also be examined and ewes with defective udders marked for subsequent disposal.

Lambing time

In the event that ewes are not shorn, all dirty tag locks on the rear quarters and excess wool around the udder should be removed a few days before the lambs are born. This accumulation of dirt and wool may prevent the young lambs from getting the all-important first milk of the ewe shortly after birth. In addition, lambs may get the wool into their mouths and eventually their stomachs, where it forms into hard balls. Quite frequently these wool balls block the digestive tract with fatal results.

The first lambs may be expected approximately 145 days after the ram was turned with the flock in the fall. Ewes will become heavy in appearance, and show considerable udder development as the lambing date approaches. Grain feeding should be reduced during the 3 day period immediately preceding and following lambing. As each ewe shows definite signs of lambing, she should be placed in an individual lambing pen that has been cleaned and disinfected beforehand. Uneasiness and straining by the ewe will indicate to the shepherd that the lamb or lambs are to be born within a few hours. A ewe placed alone in a small pen can be watched more closely and will not be so likely to disown her lambs. Furthermore, the young lambs will find the mother more readily and nurse more quickly. Ewes that have had plenty of exercise during the winter months and are in good condition, usually produce strong, vigorous lambs, which are capable of withstanding considerable hardship if they have access to a generous milk supply from the udder.



Difficulties encountered at Lambing Time.

Abnormal presentations—In a normal presentation the front feet protrude first; the nose and head follow, lying flat on the front legs. Occasionally the position is reversed with the hind legs emerging first. If one or both front legs are turned back, the ewe will experience difficulty in lambing unless given assistance. Before any internal examination is made with the hand, the assistant should trim his finger nails closely and wash his hands with soap and water to which a disinfectant has been added. A satisfactory hand lotion can be made by mixing one ounce of carbolic acid with one quart of olive oil. After the hands have been smeared with this mixture, nothing should be touched from which dirt or germs may be carried into the ewe.

If the position of the lamb is wrong, it must be corrected. When the front legs are inverted, the lamb must be pushed back, so that their position can be adjusted. During this process the hand may be inserted into the vagina so that the lamb's head can rest on the arm while the legs are being gently manipulated into proper position. Care must be taken to avoid injuring the delicate tissues of the reproductive organs of the ewe. When the legs have assumed a normal position, a light cord saturated in oil may be attached to them, and gentle pulling on the cord when the ewe strains will usually result in the lamb being delivered successfully.

The chilled lamb—Lambs chilled at birth can be successfully revived if placed in warm water for a few minutes. The water should be as warm as the human elbow can bear. After being immersed the lamb should be rubbed

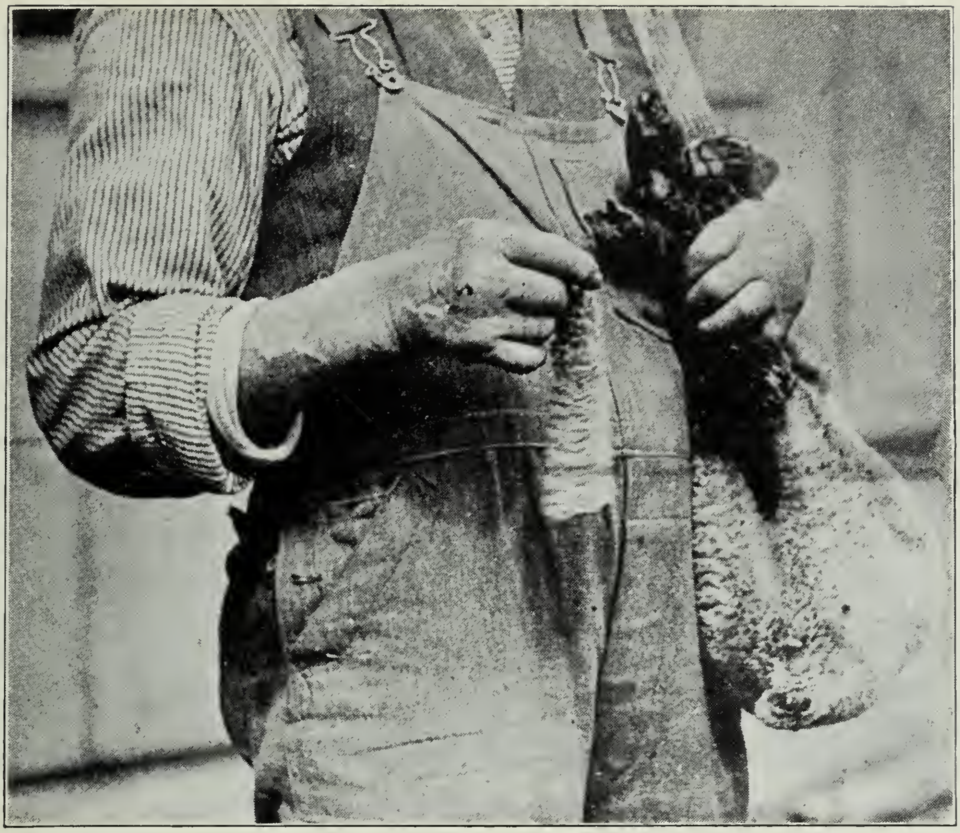
After And Before Trimming

briskly with a warm cloth until reasonably dry, then placed in a woolen cloth or blanket. A few drops of milk direct from the ewe, fed with a spoon, will act as a stimulant. The lamb should be returned to the ewe as soon as it shows signs of revival, otherwise the mother may disown it.

The disowned lamb—Frequently the ewe will refuse to own her lamb, especially when she is allowed to lamb while running with the flock in confined quarters. During the first few days, the ewe identifies her lamb by a sense of smell. Smearing some of her milk over the body of the lamb may bring about recognition. Rubbing the lamb on the nose of the ewe frequently produces satisfactory results. Keeping the ewe and the lamb together in the small lambing pen for a few days may also be effective. As the lamb grows older and stronger it will probably be able to nurse in spite of the ewe's protests. If not, the ewe should be held by the shepherd while the lamb nurses, thus acquainting her with it. This procedure is particularly effective in the case of young ewes with their first lambs.

The orphan lamb—Usually the orphan lamb can be raised successfully on cow's milk. One tablespoon of milk every two hours is sufficient for the lamb during the first day. Since the natural milk from a ewe will run from about 5 to 7% in fat any cow's milk used should have approximately the same fat content. If some milk can be secured from a fresh ewe for the first few days, it is better for the young lamb. All milk should be kept in clean utensils, and fed at body temperature (100°F.). After the first few days and until the lamb is 3-4 weeks old, milk may be fed 3 times daily at the rate of 8 ounces per feeding. An orphan lamb can be taught to drink milk out of a dish or pan by allowing it to suck on a finger, while placing its mouth in the milk.

Under normal conditions, the ewes and lambs are removed from the individual lambing pens when lambs are two to three days old. The quantity



Docking Properly Done

of grain fed to the ewes should be increased a week after lambing. Lambs will make rapid gains if the ewes are milking well. However, a heavy milking ewe may produce more than one lamb can take. In such cases the grain ration should be reduced, otherwise udder trouble may result.

As a general rule lambs can utilize grain to advantage upon reaching 3 weeks of age. This should be placed in a trough in a creep accessible to the lambs, but not to the ewes.

As the season progresses, the entire flock should be turned to pasture after having been treated for internal parasites. If external parasites are in evidence, it is advisable to dip all sheep and lambs about a week or ten days after the ewes have been shorn.

Docking

All lambs, both male and female, should be docked when about ten days of age. Ewes with docked tails are more likely to get with lamb at breeding time and docking improves the general appearance of a group of market lambs. Moreover, sheep that have been docked are not likely to get very dirty around the rear quarters when turned on to lush pasture or rape. Docking is a simple operation if done at the proper time. A sharp jack-knife is quite suitable for this purpose. The lamb should be held with the head up and back towards the attendant. The left front and left rear legs are held in the left hand, and the right front and right rear legs in the right hand. When held in this position the underside of the tail will be facing upwards. The second joint from the body of the lamb is located with the left hand of the operator. After the skin has been pushed slightly towards the body the knife should be placed on the spot between the joints. The tail should be held straight out and the knife drawn quickly downward until the tail is severed. Lambs three weeks to a month old may bleed profusely. Bleeding can be stopped by tying a cord tightly around the stump and allowing it to remain there for 15-20 minutes or until the blood clots. It is advisable to remove the cord when the bleeding has stopped. The knife should always be sterilized in an antiseptic before each amputation.

Castrating pincers may also be used in docking. Under this method the tail is crushed at the second joint, then severed with a knife at the point immediately inside the jaws of the pincers. The crushing process reduces the amount of bleeding, but does not eliminate it entirely.

Castrating

All ram lambs except those being kept for breeding purposes should be castrated before reaching one month of age, and preferably when 10-14 days old. Entire males intended for market frequently lose weight during the fall months when they should be gaining. As a consequence the meat is lower in quality and often develops a strong flavour. Perhaps the oldest method of castration, namely use of the knife, is still the most satisfactory. The lamb should be held in the same position as for docking. The lower third of the scrotum is cut off with a sharp knife that has been thoroughly disinfected. The membrane encasing each testicle is slit and the testicles are drawn out, one at a time, with the fingers. The operator's hand must be clean and disinfected to prevent infection.

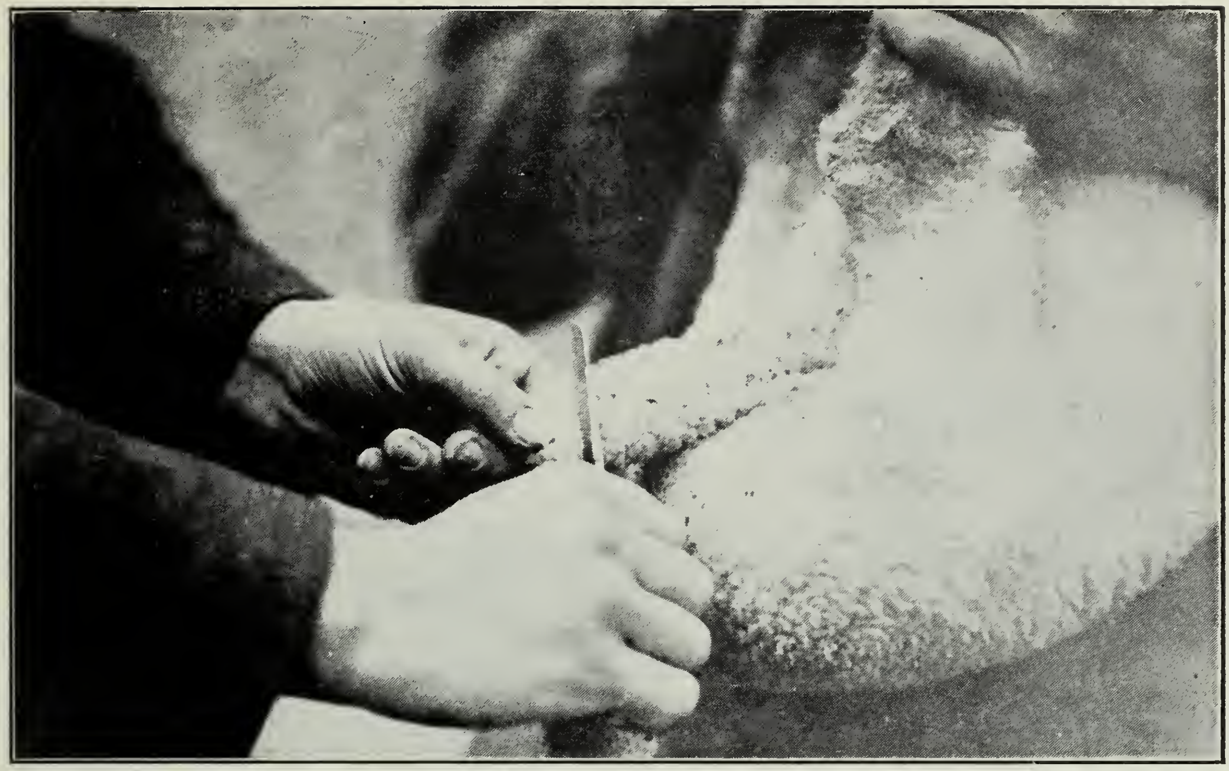
A mixture of equal parts of pine tar and lard on the wound will help prevent infection, and act as a fly repellent at the warm seasons of the year. The newly castrated lambs should be given clean quarters, and not exposed to extremes in temperature, particularly cold. If the weather is warm, a clean, grass plot is the best place for the lambs.

Castration with Burdizzo pincers has become a common practice. This method is bloodless, and leaves no wound, and, when properly done, is equally as effective as the knife method. The lamb is held in the usual way by an attendant. The operator should make sure that the testicles are well down in the scrotum. The cord at the right side of the scrotum is located with the left hand, and the pincers are placed well above the testicle, closed and left locked for a few seconds. They are then removed and the same procedure is followed on the cord at the left side of the scrotum. Each cord must be crushed separately, the centre area of the scrotum being left untouched, otherwise the blood will not circulate to the lower part and it will slough off.

It is folly to attempt to castrate older lambs with the pincer method and send them to market shortly afterwards. A spoiled carcass, very much decreased in value, is the usual result. It is therefore imperative that all male lambs intended for market be castrated at the proper age—ten days to two weeks.

Summer care of the flock

Supplying good pasture, water, and salt, and giving general attention to the health of the ewes and lambs constitute general summer care. Sheep relish a change of pasture, and the flock will do better if this can be provided. It should be recognized that sheep prefer dry ground, and will usually pasture on the higher land in preference to low-lying areas. Rotational grazing and provision of highland pasture also play an important role in the control of internal parasites.



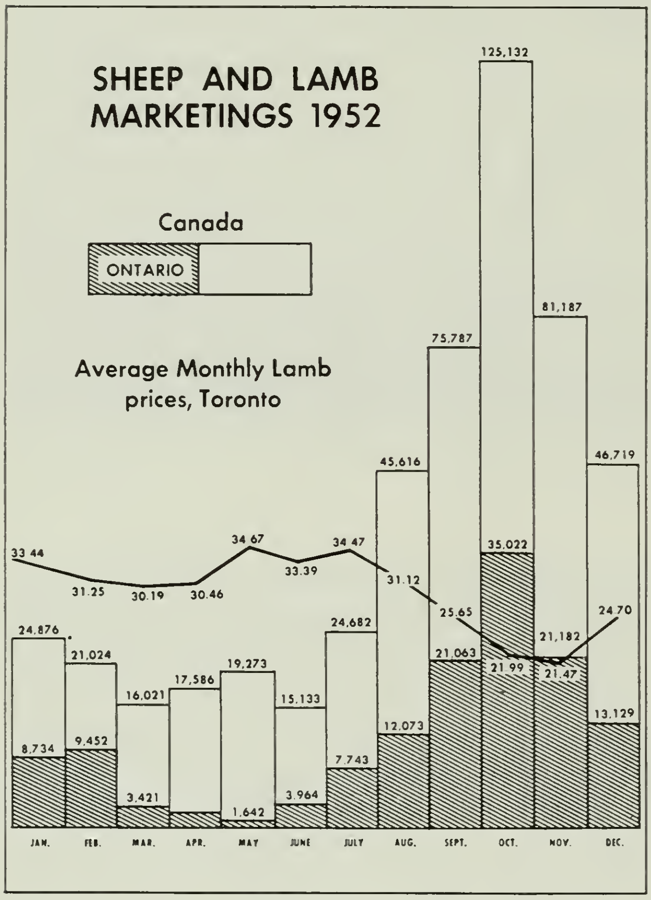
Proper Method of Castrating

Weaning

Lambs are usually weaned after August 1st, depending upon their age. When lambs are separated from the ewes they should be placed on good fresh pasture. Later, grain feeding may be practised. It is advisable to place the ewes on poorer pasture for a few days after the lambs have been removed. This will reduce the milk flow and lessen the danger of udder troubles. The ewe's udder should be watched carefully for a few days after weaning and stripped out by hand, if necessary, until milk secretion has ceased. Ewes with bad udders or non-breeders should be marked for culling-out. As the breeding season again approaches, the ewes should be placed on good pastures while the lambs are being prepared for market.

MARKETING LAMBS

In Canada, lambs constitute about eighty percent of the sheep population marketed annually, the balance being discards from the ewe flocks. They may be sold to drovers or packers, or consigned to commission firms or co-operative marketing agencies. About 35% of the lambs are marketed at stockyards while the remainder are shipped directly to packers.



Two methods of transportation are used in getting the lambs to their final destination, namely truck and railroad. In Ontario, three-quarters of the lambs are delivered to stock yards and packing plants by trucks.

The live grades of lamb are: "Good", "Common", "Bucks", and "Feeders". They are sorted according to body conformation, covering, quality, and weight. Lambs of desirable conformation are low-set and blocky, with uniform width, depth, and length, thus being symmetrical in shape. Covering refers to the degree or depth of finish that a lamb carries. It may vary in amount, evenness, and firmness.

Quality is indicated by the size of bone and joints in the legs, the size of head, and the degree of firmness and evenness of the flesh on the rump, back, ribs, and shoulders.

The most desirable weight for a finished market lamb is about 90 pounds. A "Good" lamb, regardless of weight, is one that has desirable conformation and finish.

Lambs are graded as "common" if they lack finish, or are of undesirable conformation. After the first of July, uncastrated male lambs are listed as "bucks", and sell at a discount. After the first of October, a further deduction in price may be made.

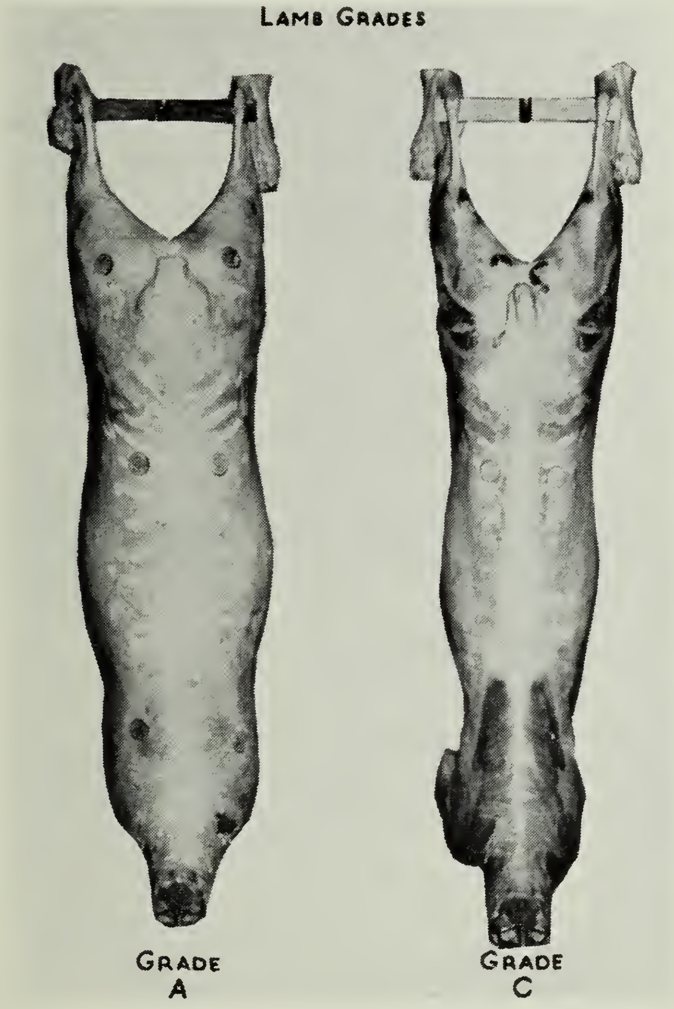
"Feeder" lambs are light in weight, and reach the market in an unfinished condition. As a general rule they originate in Western flocks and are marketed in the fall.

Approximately fifty percent of the lambs are sold off in the months of September, October, and November—October being the month of peak marketings. Due to increased supplies and the relatively low quality of some lambs marketed during this period prices usually decline. Many lambs marketed in October could be improved in quality by additional feeding.

There is a ready market for a limited number of hothouse or Easter lambs. These lambs, born in the early winter, if skillfully fed, are ready for Easter trade.

Points to remember in lamb marketing

1. Dock all lambs early.
2. Castrate all male lambs early.
3. Avoid over-feeding before shipping.
4. Do not over-crowd in stock cars or trucks.
5. Never lift a lamb by the wool.
6. Market lambs when they reach the correct degree of finish.



Lamb Carcasses

Canadian consumers have a preference for retail cuts from lamb carcasses weighing about forty to forty-five pounds. The dressing percentage of lambs ranges from forty-eight to fifty-five per cent, or even higher in the case of highly finished show lambs. Inferior lambs may dress even lower than forty-eight per cent. If it is assumed that the average yield is fifty per cent, forty to forty-five pound lamb carcasses will be produced from lambs weighing eighty to ninety pounds.

Lamb differs from mutton in the colour of the lean, marbling (intermingling of the fat with the lean), and bone. Lamb is lighter in colour of lean, has less marbling and bone which is reddish in colour. One of the chief points of differences is the presence of the break joint in lamb.

Classes and grades of lamb carcasses

The range in weights in each grade of lamb carcasses is as follows:

Class 1. Carcasses not more than 46 pounds.
Class 2. Carcasses more than 46 pounds and less than 51 pounds.
Class 3. Carcasses more than 51 pounds and less than 56 pounds.
Class 4. Carcasses weighing more than 56 pounds.

The grades are as follows:

Grade A

Carcasses having excellent conformation, finish, and quality. These carcasses are blocky and compact, with short, plump, legs; broad, thick backs;

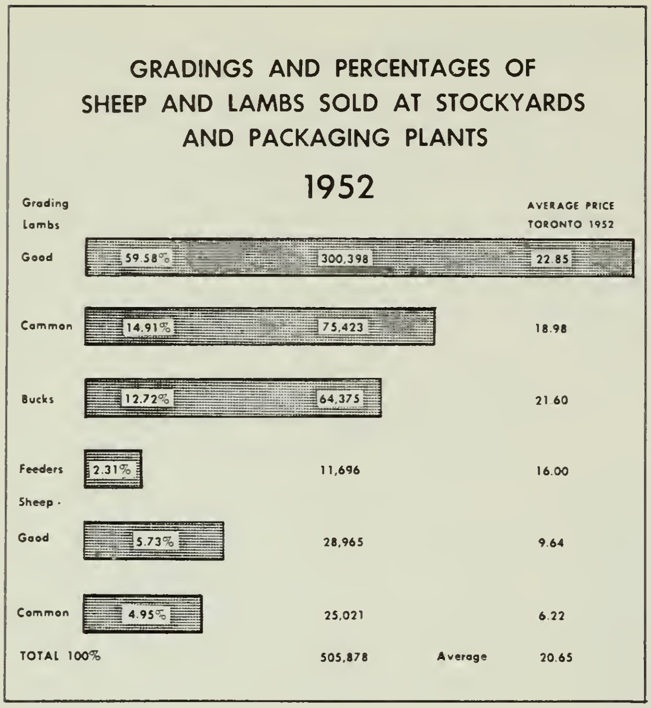
and thick, full loins, ribs, and chucks. Carcasses should be well, but not excessively covered with fat. A bright, attractive colour is desirable.
Weights—Class 1, 2, 3, 4.

Grade B

Carcasses having good conformation, finish and quality.
Weights—Class 1, 2, 3, 4.

Grade C

Carcasses having fair or medium conformation, finish, and quality. This grade may include overfinished carcasses.
Weights—Class 1, 2, 3, 4.



Grade D

Carcasses having poor conformation, finish, and quality but having some tract of exterior fat covering. This grade may include excessively overfinished carcasses.

Grade E (Culls)

1. Carcasses lacking in finish, quality, and general conformation, so as not to qualify for Grades A, B, C, or D.
2. Carcasses having serious physical injury.
3. Carcasses having definite spear grass infestation.
4. Carcasses that are coarse and lacking in quality.

Carcasses from male lambs that have not been castrated shall, in any case, be graded in accordance with the prescribed grades, but when proof of the condition is evident to the grader, such shall also be designated separately on the grading certificate as "bucks".

DISEASE PREVENTION

The following section has been prepared to guide sheep producers in the methods of keeping their flocks healthy. Very often, through intelligent knowledge of diseases, losses from such may be avoided. The majority of flocks in Ontario are healthy. The best insurance to keep them so is to apply the old rule that "an ounce of prevention is worth a pound of cure".

Abortion

Although abortions due to infection occur in sheep, the Brucella organism (the most common cause of abortion in cattle) does not appear to be an important factor. Probably the most important bacterial cause is **Vibrio foetus,** but other organisms are frequently found in aborted lambs.

Marked symptoms prior to abortion are exceptional. Occasionally the fleece may be soiled by a brownish discharge a day or two before the expulsion of the fetus. Abortion may occur at any stage of gestation, but is more common during the last third of the pregnancy period. As a rule, the ewe is not seriously ill following abortion, although a discharge from the vagina is observed for days or even weeks. On occasions, an outbreak may occur due to infection with a particularly virulent organism which causes severe illness or death in a high proportion of the aborting ewes.

Abortions have been reported which appear to be due to nutritional causes. Predisposing factors are dry pasture conditions followed by poor roughage and general undernourishment of the sheep. While vitamin A deficiency may be the main contributory factor, ewes aborting under these conditions are generally deficient in a number of nutritional factors. The condition is easily prevented by adequate feeding.

When infectious abortion is suspected, care should be taken to collect and destroy all aborted lambs, foetal membranes, and contaminated bedding. Contaminated pens should be cleaned and disinfected and, when possible, pregnant ewes should be kept out of them for the remainder of the season. Aborting ewes should be isolated until all discharge has ceased or, preferably, until the lambing season is over. Generally, ewes which have aborted are thought to shed the infection before the next breeding season.

Foot Rot

Foot rot is an infectious disease in which infection develops beneath the horny part of the foot, causing lameness and sometimes separation of part of the hoof from the underlying tissues. It is more prevalent in wet seasons when the sheep are at pasture, but may occur at other times. In some flocks, the disease reappears every year. It is believed that bacteria causing the disease are carried over in the feet rather than in the soil.

When an outbreak occurs in a flock, affected sheep should be removed for individual treatment. The normal members of the flock should be walked through a foot bath containing 5% copper sulphate solution and put into a field which has not carried sheep for at least two weeks.

Affected sheep should be examined separately. When necessary, the horn should be trimmed from the underlying diseased tissue. Then the affected foot may be dipped in 10% formalin solution for ten seconds; this treatment should be repeated every third or fourth day until healing occurs. Care should be taken to remove from the flock chronically infected animals which do not respond to treatment since they are the medium through which the infection is carried over from year to year.

Enterotoxemia

This disease occurs in sheep of all ages, although it is seen most frequently in sucking lambs and in lambs in the feedlot. It is associated with a high food intake, either through heavily milking ewes or by heavy grain feeding. Corn seems to be more dangerous in this connection than other commonly fed grains. The actual cause appears to be a bacterial poison formed in the intestine and absorbed into the blood stream.

Symptoms develop rapidly and often the first sign of the disease is a dead lamb. Nervous symptoms predominate and include holding the head back or to one side, excitement, and convulsions. Diarrhea occurs on occasions and it is considered to indicate that the animal will recover. As a rule, the death rate among affected animals is high. The proportion of a flock showing symptoms varies widely in different outbreaks.

Vaccination has proved effective in reducing losses. In addition, management practices can aid greatly in preventing the condition. When the disease occurs in sucking lambs, the milk flow of the ewes should be reduced by lowering the amount or quality of the feed. In the feedlot, lambs should be brought to full feed gradually. Large, "bossy" lambs should be prevented from getting more than their share of concentrate. When the disease occurs late in the feeding period, it may be advisable to market the heavier lambs and to reduce, for a few days, the concentrate intake of the remainder.

Listeriosis (Circling Disease)

This bacterial disease occurs occasionally in Ontario flocks. Most cases occur during the winter months. An association with silage feeding has been claimed, but the connection is not clear. Sheep of all ages may be affected. The manner of transmission is unknown but, since many animal species can be affected, it is thought that rodents such as rats may be the source in some outbreaks.

General listlessness accompanied by a discharge from the nose is usually the first symptom observed. Temperature may be high in the early stages. Drooping of one ear often occurs early in the course of the disease. Later, the head may be turned to one side causing the animal to walk in a circle. Not infrequently, a discharge comes from the eyes and blindness may develop. The animal finally goes down with its head pulled around to one side and dies after several days in this position. Few affected animals recover. Losses may be as high as 10% of a flock but are usually less than 5%.

Prompt antibiotic treatment appears to lower the death rate in some outbreaks. Vaccination has not proved to be of value. Isolation of affected animals is to be recommended, but an effective preventive program awaits the discovery of more detailed information on the manner in which the disease is spread.

Mastitis (Bluebag)

Like the corresponding disease in cows, mastitis in ewes may be caused by any one of a number of bacterial species. Injury and chilling may also be important factors aiding in the development of the disease.

The disease usually occurs well along in the lactation period. The udder becomes hot and sore to the touch, the temperature rises, and the ewe goes off feed. Secretion from the affected side may be reddish or yellowish and contain clots. If the udder becomes gangrenous, the chances of recovery are slight. However, more frequently abscesses form in the udder resulting in permanent loss of function.

The prevention of the condition is extremely difficult under ordinary farm conditions. When the disease occurs as a flock condition, milk samples should be submitted to a laboratory to determine the type of infection present. On occasions, a bacteria prepared from such cultures may have value in controlling the outbreak. Certain of the sulfonamide drugs and antibiotics sometimes help to reduce the mortality rate. In the early stages of gangrenous mastitis, cold packs applied to the udder are recommended.

Stiff Lamb Disease

This condition occurs commonly in Ontario among young lambs during their first days or weeks of life. Affected lambs first show stiffness, particularly in the hind limbs, and a tendency to tire easily. The appetite is not impaired, there is no pain in the limbs, and the temperature is normal. However, eventually the lamb is unable to rise, and death may be due to starvation or concurrent infection.

Some investigators have found that the inclusion of cull beans in the ration of the ewe predisposes to stiff lambs. It is generally agreed that a vitamin E deficiency is involved. The exact conditions under which such a deficiency can occur are unknown, but heavy feeding of fish liver oil may contribute to it.

Wheat germ oil or other vitamin E supplements are effective both in preventing the development of the condition and in treating established cases.

Pregnancy Disease (Ketosis)

This is a highly fatal disease of ewes which occurs in the latter part of pregnancy. Most frequently affected ewes are found to be carrying twin or triplet lambs. Fat ewes appear to be most susceptible, particularly when subjected to an interruption in food intake such as that caused by transport or deliberate food restriction prior to lambing.

Affected ewes are seen to lag and to walk unsteadily. The appetite is impaired or absent, and many affected ewes grind their teeth. Blindness is a common symptom. Finally the ewe goes down, becomes comatose, and dies within a few days. When abortion or normal expulsion of the lamb occurs during the course of the disease, recovery is not infrequent.

Treatment is seldom successful, although tonics to promote appetite and injections of glucose solution may be of some value. Some veterinarians report that recovery sometimes follows the administration of glycerine by the mouth.

The principal point in prevention is to have the ewes on a rising, rather than a falling, plane of nutrition during the latter part of pregnancy.

Contagious Ecthyma (Sore Mouth)

This virus disease occurs occasionally in Ontario flocks, most frequently in sheep brought in for feeding. It appears to be transmitted by direct or indirect contact.

On the lips, blisters develop which rapidly break with the formation of thick, brownish scabs. Scabs may form also around the nostrils and eyelids, and occasionally around the feet. Udders may be affected if the disease is present in suckling lambs. Sheep of all ages may be affected, although it is more prevalent in the young.

As a rule the scabs drop off and heal within two or three weeks. While the disease shows a tendency to affect the majority of a flock, the death loss is seldom more than 10%. Death may be due to interference with feeding or to internal complications.

It is questionable whether treatment alters the course of the disease, although painting the affected areas with iodized mineral oil may be of value. Isolation of affected animals is seldom practicable since the whole flock is usually exposed before the disease is discovered. In areas where the disease is an annual problem, vaccination is advised.

Blue Tongue

This disease has never been found in Canada but has recently appeared in California. It is caused by a virus but is not contagious in that it cannot be transmitted by direct contact. The blood of affected sheep harbours the virus which is passed to uninfected sheep by insects.

Symptoms start with a rise in temperature which may continue for a week or more. The lining of the mouth becomes reddened and later turns bluish. Ulcers may form in the mouth and the breath becomes offensive. Lameness is a common symptom, and examination reveals heat and swelling around the top of the hoof. Loss of condition is rapid. The mortality rate is generally not more than 10% but loss of condition and wool may be severe.

If blue tongue is suspected, the fact should be reported immediately to a practising veterinarian or to the nearest representative of the Health of Animals Branch, Canada Department of Agriculture.

Scrapie

Scrapie is a disease of mature sheep which is prevalent in certain parts of Great Britain but which has occurred rarely in Canada and the U.S.A. It is caused by a virus which is peculiar in that a year or more is required between the time of infection and the development of symptoms.

The disease develops gradually. The first symptoms observed may be excitement, grinding of the teeth, and itchiness. The sheep moves with a wobbly gait and may go down and be unable to rise. Convulsions are not uncommon. There is no rise in temperature and, in many cases, affected sheep continue to eat. Seldom does an affected sheep recover.

Scrapie is a reportable disease. Suspected cases should be reported immediately to a practising veterinarian or to the nearest representative of the Health of Animals Branch, Canada Department of Agriculture.

PARASITE CONTROL

INTERNAL PARASITES

Regular treatments and good sheep-pasture management will generally keep worm infestations under control. There are many species of internal worms which may infest sheep. The majority of worms inhabit the organs of the digestive system. Certain worms infest the lungs, body cavities, muscles, and other organs. Most well-fed, healthy sheep will tolerate a large worm population without showing serious effects. When, however, worms reach a certain level in numbers and the sheep are in poor condition, sickness and death from parasitism occur.

Worms reproduce by laying great quantities of microscopic eggs. Most of these eggs pass out of the body with manure. Pastures become contaminated with increasing numbers of eggs in which young worms develop. Sheep become continually reinfested by swallowing eggs and young worms as they graze. In some cases, the worms develop partially in small snails, slugs, or mites, which the sheep also devour as they feed. Most worms reach maturity within the sheep in a few weeks while others take longer.

Worms may feed on blood, food in the bowels, tissues of the sheep, and exudates in the lungs. Serious infestations cause scours, anaemia, emaciation, coughing, other symptoms, and death, depending on the species of worms present. Worms also cause such conditions as inflammation of the bowels, "pimply gut", bronchitis, and pneumonia. The most serious worms are often small and overlooked, while some of the less dangerous species are large and easily seen. Over fifty species of worms may infest sheep.

Roundworms

Roundworms, varying in size from the invisible to several inches in length, are the most common parasites of flocks. The majority of the worms are from one-half to one or two inches in length. Most are light coloured, but species which suck blood are red or brown. Some worms are difficult to find unless special methods are used to expose them. The bulk of the roundworms are parasites of the digestive tract. The group includes gullet worms; minute stomach worms, twisted stomach worms, brown stomach worms, and medium stomach worms. The small intestines harbour diarrhea worms, nodular worms, hookworms, bankrupt worms, small hair worms, thread-necked worms, and numerous species of small intestinal worms. The large bowels are invaded by nodular worms, large-mouthed bowel worms, sheep pinworms, and whipworms.

Thread and Hair Lungworms

These parasites are found in the bronchi, bronchioles, and lung substance of sheep and cause husk, a common condition in flocks, especially where pasture rotation is impractical. Sheep become infested with thread lungworms from manure-contaminated food and drinking water. Hair lungworms are transmitted by small pasture snails and slugs. Dry pasture and shelters, good nourishment, and avoidance of overcrowding are the best protection against lungworms.

Tapeworms

Tapeworms are common parasites of sheep. Too often they are mistaken for the cause of the illness which is produced by the less conspicuous, small, blood-sucking roundworms. The most familiar tapeworms are the intestinal parasites which attain a length of many feet. They pass part of their lives in small mites abundant in pasture lands. Fringed tapeworms occur in the bile ducts of sheep in certain areas of North America and may interfere with the function of the liver. Larval forms of tapeworms, commonly called bladder worms or water balls, include the thin-necked bladder worms so often seen at the time of butchering attached to the liver or caul.

Other bladder worms, fortunately less common in Canada, are the gid worm which lodges in the brain of the sheep, the sheep measles bladder worm located in the muscles, and the large hydatid worm usually located in the liver or lungs. The latter also infests man. All the bladder worms in sheep are caused by contamination from the dung of dogs and such wild animals as foxes and wolves which contaminates sheep pastures. As a control measure, farm dogs should be treated regularly for tapeworms to protect sheep from bladder worm infestations.

Flukes

Flukes occur in the paunches and livers of sheep. Large liver flukes may cause serious damage where sheep have access to low, damp pastures. The development of these flukes involves passage through mud snails. Recent work indicates that ants may have a role in the development of the small lancet flukes found sometimes in large numbers in the bile ducts of sheep. Control of flukes is chiefly through selective pasturing or the destruction of mud snails.

Diagnosis of internal parasitism

The common forms of parasitism are soon recognized by the observant sheep producer, either by the symptoms which the animals show or by the lesions found at butchering time. When lambs or breeding stock become unthrifty, cough, or show signs of scours and anaemia (pale appearance), the presence of large worm loads should be suspected. However, it is a mistake to attribute all illnesses in flocks to worms. The possibility of bacterial, virus, nutritional, and other diseases must be considered. When in doubt as to the cause of widespread unthriftiness or sickness in a flock, it is best to sacrifice one or more animals for a thorough post mortem examination or to consult persons skilled in the diagnosis of disease.

Prevention of worm infestations

In preventing losses from internal parasites in sheep, the wise producer will not wait until symptoms of the disease or deaths commence. From the time he obtains his initial breeding stock, he will endeavour to keep worm populations down to minimum numbers on his premises. His success will depend on (a) good feeding and use of feed racks, (b) good water supply free from manure, (c) good drainage of pastures, (d) pasture rotation and mixed grazing, and (e) treatment for worms when necessary.

Routine treatments

In Ontario, the twisted stomach worms and nodular worms are the species for which treatments are the most necessary. When the following recommendations (which are quoted with modifications from the Ontario Department of Agriculture Extension Circular No. 74) are carried out for these worms, other roundworms may also be reduced in numbers to the point where they cause little harm. After winter freezing, pastures are practically free of the young forms of two of the most harmful parasites of sheep in Eastern Canada—the common stomach worm and the nodular worm.

Before turning the adult flock out to clean pastures, it is desirable that they be treated for internal parasites. The carry-over of these two parasites is within the adult sheep and, unless removed by treatment, the worms will seed down pastures with worm eggs when the flock is turned to grass.

By the use of this knowledge, a program of parasite control can be worked out and practised. Where the services of a veterinarian are available, consult him regarding your parasite prevention program. Such a program is well worthwhile, which will be seen from the appearance of the flock throughout the summer, and by the condition of those kept over the winter.

The use of phenothiazine for treatment against sheep parasites has now been universally adopted. This drug may be given in the form of tablets, as a drench, or mixed in powder in the grain-feed or with salt.

The plan of campaign of parasite control is briefly as follows: (1) All adult animals in the flock should be treated with phenothiazine tablets in the late winter or early spring. The suggested dose of phenothiazine for animals over 100 pounds in weight is 30 to 40 grams. Twenty-four hours before the flock is turned to summer pastures is a good time. (2) From early July onwards, if signs of stomach worm disease are noted, all lambs should be treated with a drench of blue-stone and nicotine, a small dose of phenothiazine, or some other recognized stomach-worm remedy. (3) If diarrhea and general unthriftiness caused by worms are noted in the autumn, the flock should again be treated with phenothiazine.

When administering phenothiazine (1) Sheep should always be handled gently and carefully. (2) They should not be starved before treatment. (3) If treatment is given just before turning the flock out to clean pasture, the flock should be held for at least 24 hours in order to give the drug a chance to act on the worms. After holding for 24 hours, there is little danger of contaminating pastures. (4) Ewes treated within a month before lambing and ten days after must be handled with the utmost care because abortions or other complications may result. (5) If used properly, phenothiazine is safe and effective. However, it must be used with care and with intelligence. Before using any worm remedy, it is best to treat two or three animals first in order to be sure that no unexpected results occur. The directions on the manufacturers' labels for all preparations should be read and strictly followed. Judgment must be used in modifying doses for weak animals.

Phenothiazine-salt mixtures such as medicated salt mixture containing one pound of phenothiazine powder mixed with 9 to 14 pounds of salt may be made available to the flock at pasture if desired. Such a mixture will be readily taken by the flock, and may be effective in reducing both the worm-burden of adult animals and the seeding down of pastures with worm eggs. The use of phenothiazine-salt mixtures is recommended only under certain conditions.

Wool discoloration is common after treatment with phenothiazine, since the urine of animals will contain large amounts of red stain for several days after dosing. If the ewes have not been shorn, a part of the fleece may become permanently stained unless precautions are taken. The flock should be kept in a well-bedded yard or, preferably, treated after shearing.

A standard copper-sulphate nicotine-sulphate drench, if preferred to phenothiazine, can be used effectively to combat stomach worms and tapeworm infestations. Preliminary starvation for 12 to 18 hours before dosing is often practised, otherwise the same precautions as those indicated for phenothiazine must be taken. The flock should be treated before being turned to pasture in the spring, and the lambs drenched in late June or early July, depending on the season. Lambs should be two months old before receiving their first treatment. If necessary, treatment should be repeated after 40 to 45 days.

The preparation of the drenching solution is as follows:

Crystals of copper-sulphate (blue-stone)	3 ounces
40 per cent nicotine-sulphate	2 fluid ounces
Soft (rain) or distilled water	I Imperial gallon

The copper-sulphate must be dissolved in a glass, earthen-ware or enamel crock. The nicotine-sulphate **must not** be added until just before use.

The following dosage is recommended:

For ewes and rams in good condition	2 fluid ounces
For ewes and rams in poor condition	1½ fluid ounces
For well grown lambs	1 fluid ounce
For small lambs	½-¾ fluid ounce

Coccidiosis

Coccidia are present in most flocks and feed lots. Normally, these parasites cause little harm; under adverse conditions, they produce disease and deaths. The intestines become inflamed and white or yellow spots appear in the small intestine. The symptoms are loss of appetite, scouring, weakness, and emaciation. There is less likelihood of the disease occurring when sheep, especially lambs, are provided with dry quarters and ample acreage. The feeding of 2 per cent sulphur in grain rations helps to prevent coccidiosis. Sulfonamides may prevent, but not necessarily cure, the disease. Lambs which survive infection develop an immunity. There are nine kinds of coccidia which infect sheep and goats in North America.

EXTERNAL PARASITES

Nose Bot Flies

Female bot flies deposit up to 60 grubs near the nostrils of sheep. The grubs go up the nose and into the sinuses of the forehead where their development may continue for many weeks or a year. Finally they drop to the ground, and three or four weeks later turn into flies. The flies are active in the summer and fall, and sheep may stampede when the flies are active in pastures. The maggots may cause giddiness or staggers. The grubs cause inflammation of the sinuses and "snotty noses", which may be accompanied by sneezing and laboured breathing. No practical treatment is known at the present time. Salting troughs which automatically supply pine tar to the nostrils are used by some shepherds. Shade in the pasture will afford the sheep some protection when the nose bot flies are about.

"Sheep Ticks" or "Keds"

These pests are in reality flies which have lost their wings. They differ from true mature ticks by having only six instead of eight legs. Keds never leave the wool except by accident. They breed continuously, but become more numerous when the sheep are confined to their winter quarters. The parasites also infest goats. Heavily infested sheep are unthrifty and fail to gain. The wool becomes filthy and is damaged by the animals biting and rubbing themselves. In extreme infections, lambs on poor diet fail to grow and may die. Following shearing, the keds will leave the shorn wool and find their way to nearby lambs; for this reason freshly shorn wool should always be stored some distance from the flock. The parasite is easy to eradicate by applying dusts or by dipping. Dips may be easily constructed within or near the sheep sheds and be covered up when not in use. Dipping is more thorough than spraying since it ensures contact of the whole area of the body. In cold weather, dusts may be used. Dusts should be applied in the fall and after shearing. Preparations containing rotenone, DDT, or benzene hexachloride, which is usually used in the form of Lindane, are suitable for destroying keds. All these insecticides are available on the market under various trade names. In each case, the manufacturer's directions should be carefully read and accurately followed. Wettable powders and emulsions are usually safe for dipping.

Sucking and Biting Lice

The several species of lice which infect sheep and goats include the sheep foot lice, red lice and redheaded sheep lice. Lice live constantly on the sheep. Biting lice damage the wool fiber, and the suckling lice feed on the sheep's blood. All these pests attach their eggs to the wool or hair close to the skin. The young lice emerge from the eggs and mature rapidly. Lice become more abundant in the late winter. Infested sheep rub and bite until the fleece is broken and tufts or tagged wool appear. Lousy animals are unthrifty and restless, the fleece yield is reduced, and the lambs may be stunted. The sheep foot louse is at times abundant on the lower part of the legs and may cause lameness. Treatment for lice is similar to that recommended for keds.

Mange or Scab

Sheep are subject to four types of mange: common scab, head scab, foot scab, and follicular mange. Sheep scab is a devastating disease, and all suspected cases should be reported immediately to a veterinarian or to the local representative of the Health of Animals Branch, Canada Department of Agriculture. Canada has been fortunate in being one of the few countries in the world where the dreaded disease of sheep scab has been kept under complete control for many years. All forms of mange mites are minute creatures which develop rapidly, especially in cold, wet weather. The common scab is a highly contagious form of mange resulting in the loss of much fleece and injury and thickening of the skin over large areas of the body. Head scab is confined chiefly to the head and face, and foot scab to the lower parts of the legs. Follicular mange is usually confined to the eyelids of sheep and is associated with small nodules containing puss and mites. Treatment for common scab is designated and supervised by federal veterinarians. The other forms of mange will respond to lindane sprays and dips, or other approved commercial preparations containing lime and sulphur or other recognized mange remedies. Treatment, however, should not be undertaken until it is definitely ascertained by microscopic examination of suitable scrapings, whether mites are present.

Wool Maggots and Screwworms

Fly maggot infestations in the wool, under the skin, and in wounds are fortunately not as common in our latitudes as they are farther south. Various species of blow flies and screwworm flies do occasionally attack sheep, especially those with soiled fleeces, body discharges, or injuries. The screwworm flies and sometimes blow fly maggots will invade healthy tissues through insect bites, surgical wounds, or other injuries. To avoid maggot injuries, a close watch should be kept on flocks during the fly season, and breeding places of blow flies on the premises should be removed, especially carcasses, offal, and similar material. Treatments for fly maggot infections include solutions of lindane or lysol.

In Australia, or other countries where fly blow is a major problem, jetting and cruching are practised.

Pasture Flies and Ticks

The term "pasture flies" includes varieties of the blood-sucking and annoying flies such as horse flies, mosquitoes, black flies, stable flies, etc., which pester animals at pasture. Although it is seldom practical to eradicate these pests completely, flocks may be given some degree of protection by the owner providing shade in the form of trees or shelter at pasture, by eliminating known fly-breeding places and, possibly, draining or oiling swamps.

The Ontario sheep raiser, at the present time, has little need to be concerned about true ticks other than to ensure that animals shipped into these areas are inspected and, if necessary, treated. In countries where ticks are numerous, they reduce vitality and transmit such diseases as tularemia and tick paralysis. Tick control varies with the species concerned, but essentially includes dipping of infected animals in lindane or arsenical preparations, and in treating infested pastures.

SHEEP PROTECTION

Except for the Dorset Horn breed, nature has not endowed sheep with an effective means of protecting themselves against dogs and predatory animals. Even though horns afford some protection, they are not an absolute safeguard against dogs intent on slaughter. Therefore, it becomes the responsibility of the owner to provide the protection which has been otherwise denied. Unfortunately there is no simple solution to this problem. Dog-proof fences have been suggested as a means of preventing attacks, but since such fences are costly, their use is likely to be limited. Nevertheless this type of fence proves useful in the construction of a corral. Since most attacks occur at night or in the early hours of the morning, sheep owners residing in areas where dogs are a problem are well advised to pen their sheep at night. However, the problem will never be solved in such areas until the marauders have been eliminated.

In Ontario the Dog Tax and Live Stock Protection Act has been placed on the Statutes for the purpose of giving sheep owners some protection against losses. This Act requires every municipality to levy an annual dog tax of not less than $2.00 for male dogs and not less than $4.00 for female dogs. A municipal council has the authority to increase the amount of the tax if deemed advisable. Each municipality must appoint a live stock valuer to determine the value of losses inflicted by dogs. If the owner and the municipal council are satisfied with his award, the owner is reimbursed in that amount. However, if either party is dissatisfied, the case may be appealed to the Minister of Agriculture who will name a valuer to investigate the case and whose award is final.

Dog Proof Fence

In addition the Act contains a provision dealing with the disposal of dogs that are potential killers. This section reads as follows: "Any person may kill any dog

(a) which is found killing or injuring live stock, or
(b) which in a township or village is found between sunset and sunrise straying from the premises where the dog is habitually kept, or
(c) which is found straying at any time, and not under proper control, upon premises where live stock are habitually kept."

Inasmuch as the dog has been described as "Man's Best Friend", people shudder at the thought of destroying any member of the canine family. However, when a dog becomes a potential killer he is no longer a friend of man, and must be eliminated if the sheep industry is to be preserved.

BULLETIN 500

JULY, 1954

SWINE HUSBANDRY IN ONTARIO

ONTARIO DEPARTMENT OF AGRICULTURE
PARLIAMENT BUILDINGS, TORONTO, CANADA

CONTENTS

1. INTRODUCTION 1

2. BREEDS AND BREEDING: 5
   - (a) BACON BREEDS OF SWINE 5
   - (b) NEWER DEVELOPMENTS IN BREEDS OF SWINE 7
   - (c) METHODS OF IDENTIFYING PUREBREDS AND REQUIREMENTS FOR REGISTRATION 8
   - (d) THE ADVANCED REGISTRY POLICY 8
   - (e) SELECTING REPLACEMENTS FOR THE BREEDING HERD 9
   - (f) ABNORMALITIES FOUND IN SWINE 10
   - (g) CROSSING AND CROSSBREEDING 11

3. BUILDINGS AND EQUIPMENT 12

4. FEEDS AND FEEDING: 19
   - (a) NUTRIENT REQUIREMENTS OF SWINE 19
   - (b) METHODS OF EXPRESSING NUTRIENT REQUIREMENTS 19
   - (c) NUTRIENTS 21
   - (d) CHARACTERISTICS OF FEEDS 31
   - (e) RATIONS 37
   - (f) RATION BUILDING 40
   - (g) PASTURES FOR SWINE 41
   - (h) ROOTS FOR SWINE 42
   - (i) GRASS SILAGE FOR SWINE 42
   - (j) RULES FOR SWINE FEEDING 42
   - (k) FACTORS AFFECTING CARCASS QUALITY 43
   - (l) SUPPLEMENTARY FEEDING OF LITTLE PIGS 44
   - (m) MILK REPLACEMENTS 44
   - (n) THE USE OF HIGHLY FORTIFIED FEEDS FOR RUNT PIGS 45
   - (o) THE USE OF SELF FEEDERS 46

5. MANAGEMENT 47

6. MARKETING 55

7. DISEASES OF SWINE 65

8. PARASITE CONTROL 71

SWINE HUSBANDRY IN ONTARIO

This bulletin has been prepared by a committee consisting of staff members of the Ontario Agricultural College, the Ontario Veterinary College, and the Live Stock Branch of the Ontario Department of Agriculture.

FOREWORD

During the present century, swine production has contributed as much, if not more, to the prosperity of Canadian agriculture than any other single phase of animal production. Accordingly, the information presented in this bulletin is intended to be helpful to those engaged in that branch of this extremely important industry.

If this information is applied wisely, swine can become a profitable market outlet for coarse grains, milling by-products, dairy by-products, and the by-products of other industries. Moreover the finished product, upon being further processed, is most acceptable to consumers in Canada and other countries.

These fundamentals have been kept in mind by the persons who assisted in the preparation of this bulletin. Consequently all facts and factors, which in their opinion, will contribute to the production of a quality product on a profitable basis have been included.

INTRODUCTION

Bacon exports antedate Confederation.

In 1860, seven years before the Confederation of Canada, William Davies, a pioneer pork packer, consigned a shipment of eight boxes containing 42 Wiltshires to his brother in England. This simple experiment, trivial though it may have seemed at the time, had a profound impact on Canada's swine industry. By demonstrating that bacon could be shipped successfully to the Old Country, Mr. Davies provided the incentive for an expansion in swine production, thereby paving the way for the export of vast quantities of bacon, which have brought millions of dollars of new wealth to this country. Because the British people showed a decided preference for bacon of a particular type and quality, Canadian production practices were altered to conform to their preferences. This resulted in a hog of the bacon type being adopted as Canada's "National Hog".

Exports have followed an erratic course.

During most years of the present century, Canada produced more hogs than were required for domestic consumption. The greater part of the surplus was exported to Great Britain in the form of Wiltshire sides. On a few occasions, when the American market was more attractive, live hogs and specially selected cuts were sold in the United States.

In both world wars waged during this century, those countries which constituted Britain's principal sources of bacon supplies were occupied by the enemy. Canadians were urged to increase their hog production as a contribution to the food requirements of the British people. They responded nobly, with the result that bacon exports reached exceptionally high levels on both occasions.

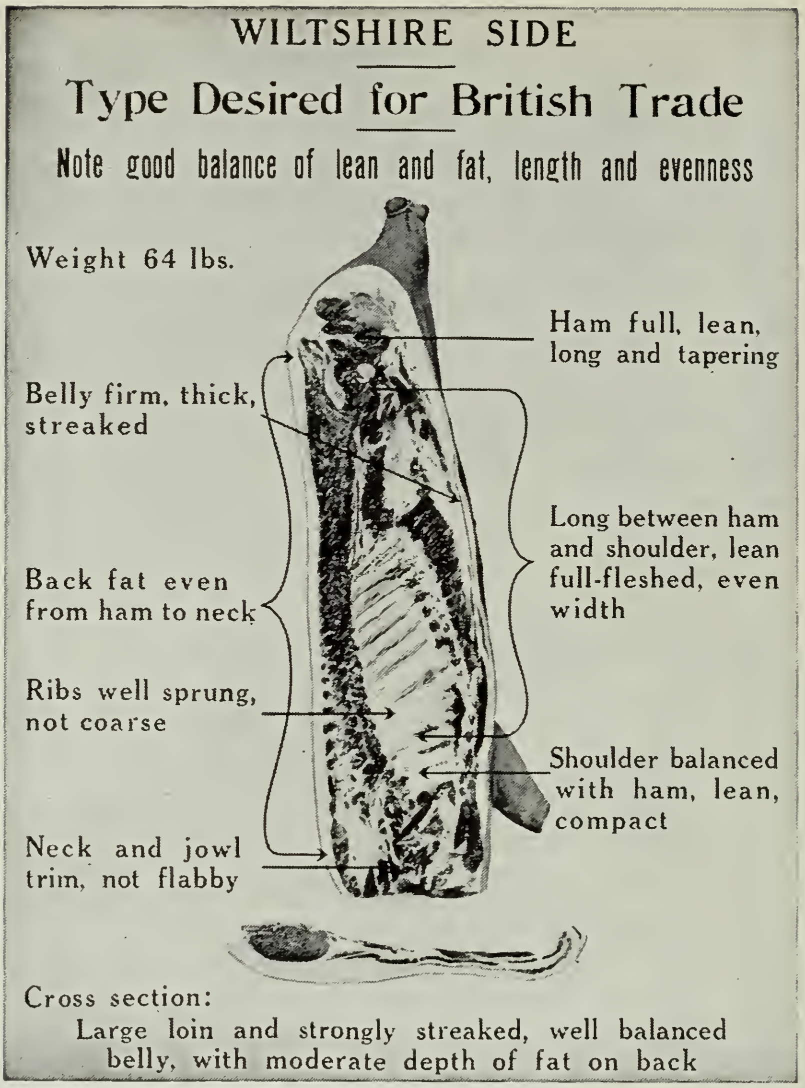
Except for the war years, the demands of the Canadian people have received first consideration, exports being confined to that portion of the product not required at home. In view of the fact that hog production fluctuated from year to year, and domestic demand was never static, exports have followed an erratic course.

Nevertheless, the British market has had a profound effect upon Canadian hog production. Invariably, producers have endeavoured to raise hogs that are suitable for processing into top quality Wiltshires.

Quality improved following introduction of grading.

During the latter stages of World War I, Canadian bacon became the object of much criticism on the grounds that it was too fat and salty. At that time, there was a tremendous overseas demand for meat of all kinds. The price of hogs was very high, and quality incentives had not been introduced. Under the circumstances, there was a tendency for farmers to raise hogs to heavy weights in order to obtain higher gross returns. Invariably the degree of fatness increased as the weight advanced. Extra salt was added in the curing because wartime conditions demanded its use as an insurance against spoilage.

After the war, it soon became obvious to Canadians interested in the swine industry that the unfavourable reputation of the Canadian product would have to be corrected if the British market was to be retained. Accordingly a conference, attended by producers, processors, and Government officials, was held


WILTSHIRE SIDE
Type Desired for British Trade
Note good balance of lean and fat, length and evenness
Weight 64 lbs.
Ham full, lean, long and tapering
Belly firm, thick, streaked
Long between ham and shoulder, lean full-fleshed, even width
Back fat even from ham to neck
Ribs well sprung, not coarse
Shoulder balanced with ham, lean, compact
Neck and jowl trim, not flabby
Cross section:
Large loin and strongly streaked, well balanced belly, with moderate depth of fat on back

in Ottawa in 1922. The group decided that improvement in the type and degree of finish of the market hogs constituted the first step in improving the quality of bacon. A system of hog grading which involved the payment of higher returns for hogs of the better grades was proposed, and later adopted by the Canada Department of Agriculture. In the original plan, shippers were granted the option of grading each producer's hogs, or of marking them in a distinctive manner, so that they could be officially graded at a stock yards or packing plant. In the early 1930's carcass grading was introduced as an optional basis. By 1940, the majority of producers appeared to favour this method; hence live grading was discontinued and rail grading officially proclaimed. Since the introduction of grading there has been a marked improvement in the quality of Canadian hogs as evidenced by the following table.

Percentages of top and second-grade bacon in Canada and Ontario.

	Canada		Ontario	
Year	**% Top Grade**	**% Second Grade**	**% Top Grade**	**% Second Grade**
1923	15.8	60.6	21.2	58.9
1931	15.6	39.7	25.5	56.3
1941	32.8	46.3	36.3	47.8
1951	33.3	44.5	37.1	45.1

N.B.: 1. Top-grade hogs, in 1923 and 1931, were designated as "Selects", and in the years following as "A" 's. In 1923, the second grade of hogs was designated as "Thick Smooths"; in 1931, as "Bacons"; and in the years following as "B1's".

2. In computing these percentages, sows and stags were not included in the total number of hogs marketed.

Meat consumption influenced by price.

Canadian workers spend about 5% of their take home pay on meat. These expenditures have enabled them to make annual purchases at a rate of approximately 135 lbs. per capita. Beef and pork account for 85% of the total meat consumption.

On the basis of past performance, it would appear that price exerts at least as much influence on meat sales as personal preference. Usually, when beef is cheaper than pork, the per capita consumption of beef exceeds that of pork, but when the price situation is reversed, pork becomes the more popular class of meat. This characteristic in the buying habits of the Canadian consumer is a vital factor in the maintenance of a fairly uniform price relationship between cattle and hogs.

The past decade has witnessed many innovations in the processing, curing, and merchandising of pork products. Cures for hams and bacons are both milder and sweeter and have greatly improved the flavour of the product. The practice of tenderizing hams has been adopted by most processing plants in response to public demand. Sliced bacon, attractively packaged and offered in open, refrigerated cases, eliminates the necessity of lining up at the butcher's counter. Pre-cooked hams and hams cooked ready to serve have a strong consumer appeal, particularly during the hot weather when housewives are reluctant to serve hot roasts. Undoubtedly these new developments have contributed to the increased demand for pork products.

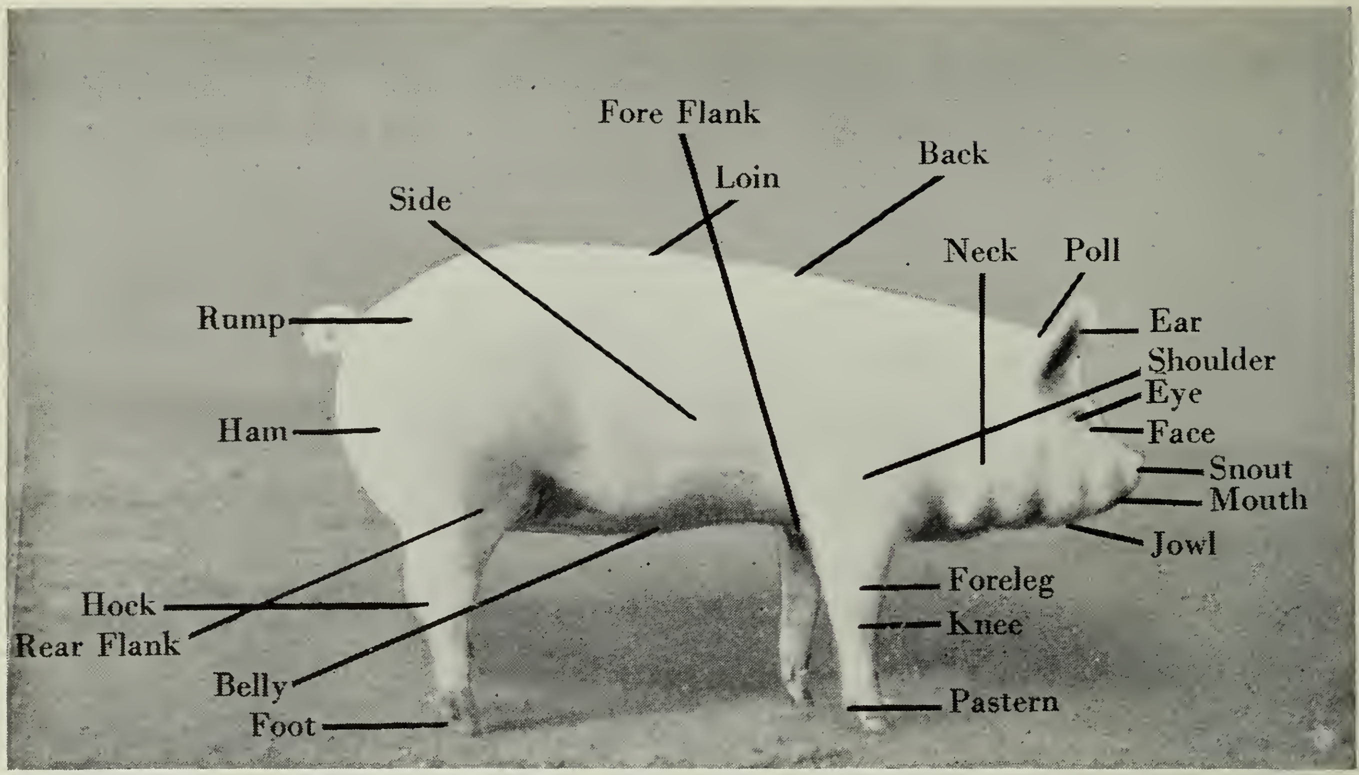
Hogs important to the Ontario farm economy

Throughout the present century, hog production has constituted an important part of the Ontario farm business. In many years, gross returns from the sale of hogs have exceeded those received from any other single class of live stock, or live stock product. A great many farmers who are free of debt credit the hog enterprise with providing the revenue required to meet their mortgage payments.

As the human population of this province has increased, more farmers have become engaged in the production of fluid milk. Health regulations forbid the keeping of hogs in that portion of the stable occupied by the dairy herd; consequently, dairymen without suitable hog pens have abandoned swine production. As more farmers go out of hogs because of inadequate facilities, operators of general or mixed farms are presented with an opportunity for increasing the size of their herds.

This trend is of particular significance to the man with limited capital because of the low initial cost of breeding stock. A young sow, representing a very modest investment, is capable of producing gross returns equal to many times her purchase price within twelve months. Few, if any, classes of live stock will produce such high dividends on invested capital in so short a period of time.

Hogs should occupy an important part in the live stock enterprise on farms operated by cream shippers and cheese producers. These persons have access to by-products which usually yield their highest returns when marketed through



Points of a Pig

hogs. Unless hogs are maintained, these by-products will probably prove valueless because of lack of a ready market.

Each farmer must determine the number of hogs he will attempt to produce. In the absence of attractive export markets, it is unwise to increase production beyond domestic requirements. Since the individual has little knowledge of other producers' intentions, it is difficult for him to gauge the number that he should raise in order to keep supply in balance with demand. However, past performance has demonstrated that the person who adjusts his production to the accommodation available on his farm, and maintains it at that level, makes a profit in most years.

Although bacon is not presently being shipped to Britain, hogs of the top grade still bring the highest returns. Bacon preferred by the British trade also commands a premium in Canada and the United States. By maintaining or, better still, by improving the present quality of their hogs, producers are placing themselves in the position to capitalize on any important export market that may become available.

BREEDS AND BREEDING

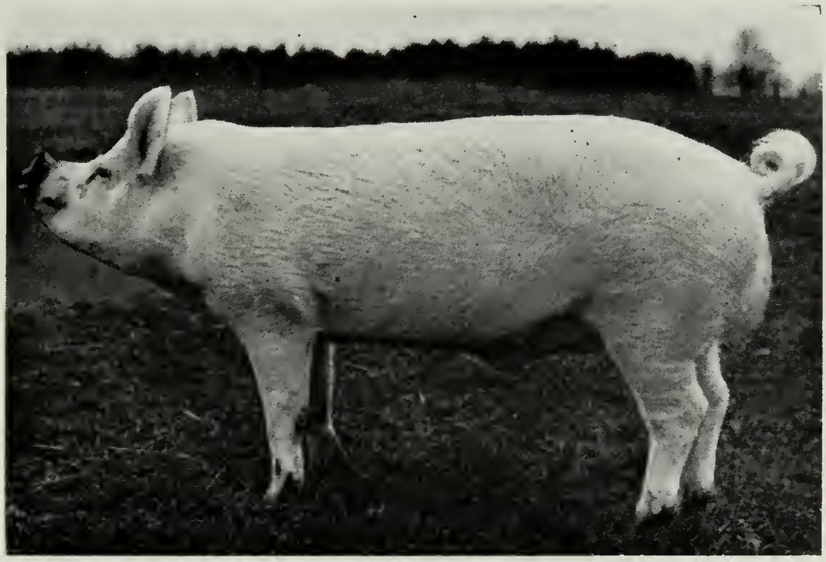
BACON BREEDS OF SWINE

The majority of swine produced in Canada have been developed from breeds of the bacon type. Since 1922, registrations of the lard type breeds have steadily decreased, as evidenced by the fact that Chester Whites, Hampshires, Duroc Jerseys, and Poland Chinas accounted for only 1.6% of the total registrations of purebred swine in 1951.

There are three bacon-type breeds of swine accepted for registration in Canada at the present time, namely Yorkshire, Tamworth, and Berkshire.

Yorkshire

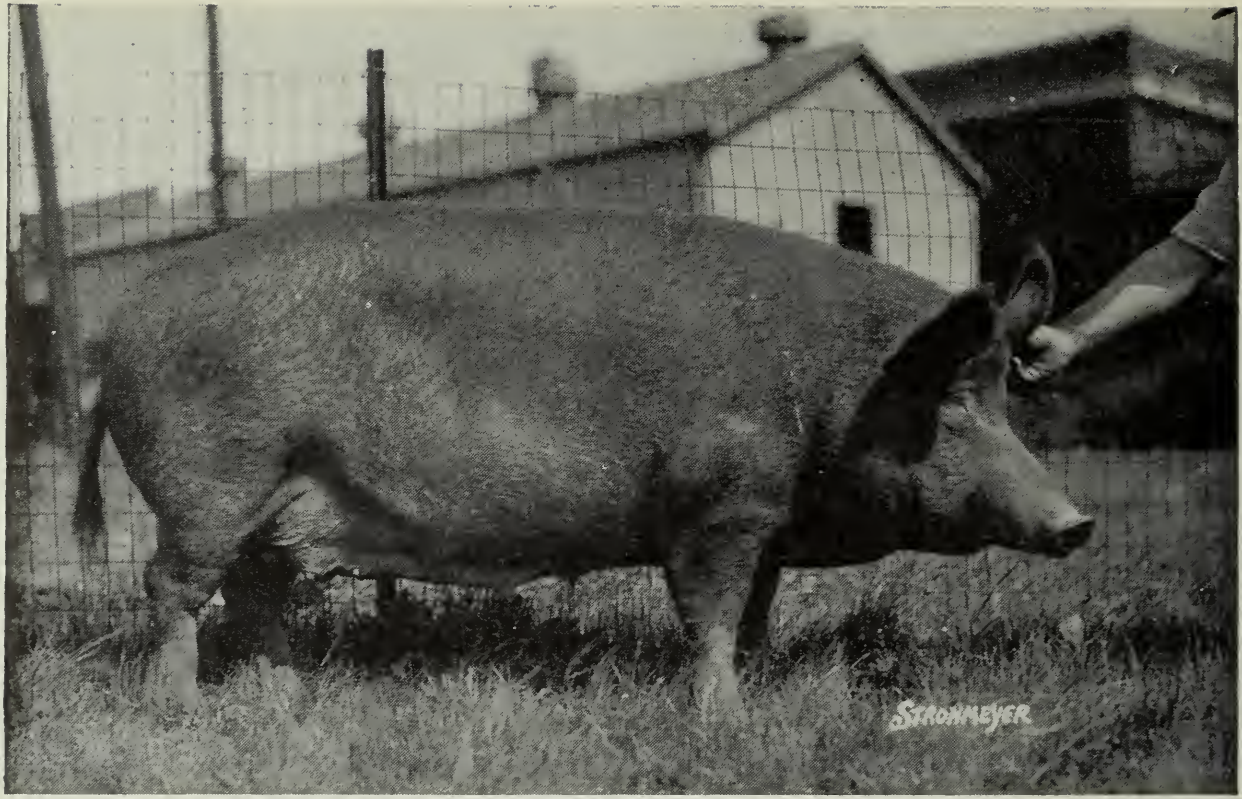
The Yorkshire is the predominant bacon breed in Canada, accounting for 88.3% of the total swine registrations in 1951. This popularity is partly due to the fact that the trade discriminates against colored hair or “seedy bellies”, conditions frequently encountered in the carcasses of dark haired pigs.



A typical, modern Yorkshire Boar

The Yorkshire, or Large white, as it is called in Great Britain and in Canada when referring to recent importations, is one of the largest breeds of swine in North America. Representatives of the breed should be clear white in colour, black hairs or black patches of hair rendering an animal ineligible for registration. Although dark or bluish spots in the skin are objectionable, they do not constitute a disqualification.

The Yorkshire is distinctly a bacon hog. The best specimens have heads of medium length, faces slightly dished and noses that are practically straight. Considerable width between the eyes, and ears of medium size, carried erect, are desirable characteristics. The neck should be of medium length, and the jowl while of fair width, should be neat and trim, with no indication of flabbiness. The shoulders should be compact and medium in width, with the width being carried uniformly throughout the body. The sides should be long and fairly deep, the whole side being so smooth and even, that a straight edge, when laid along it, will touch practically all the way from the shoulders to the ham. The underline should be trim; the ham full, free from wrinkles and tapering



A Champion Tamworth sow

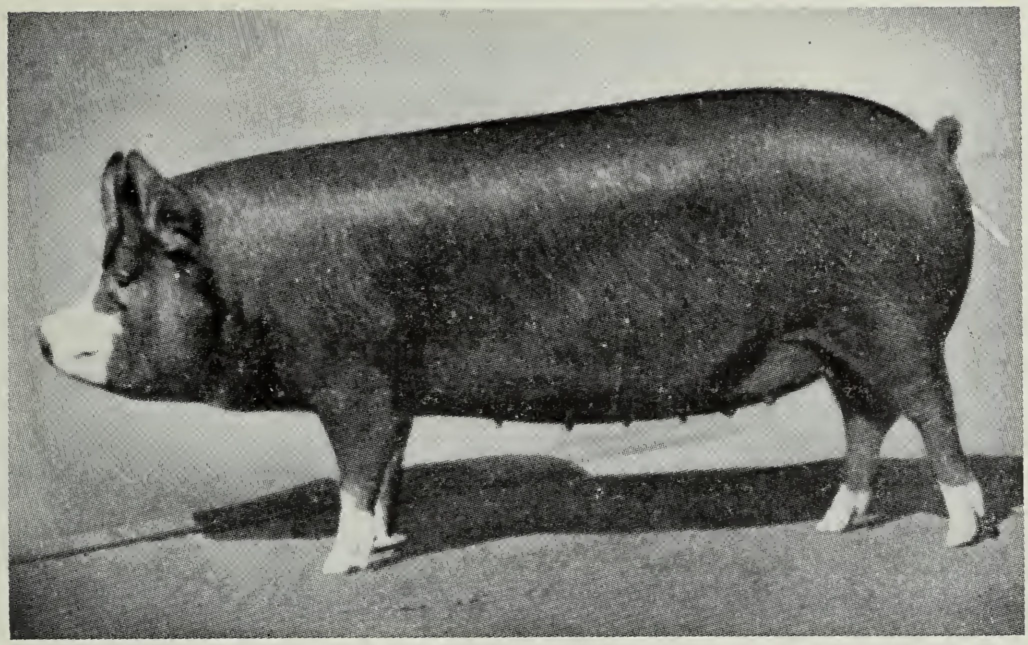
from the twist to the hock. The legs should be of medium length; the bone hard, clean and free from coarseness. All pigs, particularly breeding stock, should stand well on their legs and show plenty of strength of pasterns.

Tamworth

In 1951 the Tamworth ranked second in popularity, accounting for 6.7% of the Canadian swine registrations. This breed compares favourably in size with the Yorkshire. The desired colour is a golden red, with a flesh-coloured skin free from black. Although the red colour may vary from a very light to quite a dark shade, it usually grows darker with age. The face has a slight dish, and snout is long and straight. Narrowness between the eyes, while often noticed in this breed, is not desirable. The ears are fairly large, and carried upright or inclined slightly forward. The neck is fairly long, and the jowl shows the lightness and trimness of the bacon breeds. The shoulder is extremely smooth and medium in width, the side long and of good depth, and the ham very trim and neat. The bone is fairly heavy and of good quality.

Berkshire

In Canada the Berkshire has been developed as a bacon breed. In 1951, 3.8% of the swine registrations were Berkshires. The colour is black, with white markings on the face, the feet, and the tip of the tail. White blotches on the body are objectionable. The face is slightly dished, the snout of medium length, and the jowl full and fairly heavy. The Berkshire has a strong, broad back with a good thickness over the rump and through the ham. Individuals usually have a heavy ham which is generally quite trim. Depth of body is also a characteristic of the breed; while the bone is sometimes rather light, the best individuals stand well on their legs. Berkshires, as a breed, show a considerable amount of quality.



A Berkshire Gilt of good type

NEWER DEVELOPMENTS IN BREEDS OF SWINE

With the displacement of fat of animal origin by synthetic fats derived from the more cheaply produced vegetable oils, the emphasis in swine breeding in the United States began to shift to a "meat-type" hog. Much of the emphasis in this shift of the "thirties" was confined to a transformation of portions of the existent lard-type breeds into leaner strains, efficient in the production of a larger proportion of trimmed, meaty, primal cuts. Probably of more interest to Canadians, however, was the attention focused on new breeds, each based upon the use of at least one bacon breed in the foundation stock. Among the bacon breeds used was the Danish Landrace. Some 34 individuals of this breed were imported from Denmark in 1934 and used in experimental work by the Federal and State authorities. A few strains were established in the hands of private breeders, and some of these are now registered as the American Landrace by the American Landrace Association, Inc.

The Danish Landrace was used extensively in establishing new breeds. Some of the most commonly known ones are the Minnesota #1, from a Tamworth X Landrace foundation, and the Montana #1, from a Hampshire X Landrace foundation. The Minnesota #2 had a little different origin, the Yorkshire and Poland China being used in its development.

The interest in swine hybridizing, which followed the development of hybrid corn, was another factor which influenced the development of these new breeds. Most of the new breeds and some inbred strains within the older breeds were developed primarily for their ability to produce pork economically in crosses, that is, in "hybrid" hog production. Some new breeds, because of their superior "meat-type" characteristics have been imported to Canada by private individuals. Others have been imported for experimental purposes by the Experimental Farms Service of the Canada Department of Agriculture. These experiments, still in progress, are designed to disclose whether these new breeds have any place in Canadian bacon hog production.

METHOD OF IDENTIFYING PUREBREDS AND REQUIREMENTS FOR REGISTRATION

All purebred swine are registered in Canada by the Canadian National Live Stock Records, Ottawa. Applications can be made to the Canadian National Live Stock Records for herd letters to be used to identify all swine farrowed on the breeder's property. All purebred Yorkshire, Tamworth and Chester White swine must be identified under eight weeks of age and before weaning by tattoo markings consisting of the registered "herd letters" in the right or left ear, as designated by the Canadian National Live Stock Records, and the herd number of the animal in the opposite ear, followed by the designating year letter ("J" for 1954). All other breeds of swine may be identified in a similar manner or by a tag carrying the same information placed in the ear. A duplicate tag may be placed in the opposite ear to further assure the identity of the individual if one tag is lost.

The identification of all pigs should be entered in the breeder's private record book. This record book must be made available, upon request, to any official of the Canada Department of Agriculture or of the Canadian National Live Stock Records.

Yorkshire, Tamworth, Berkshire, Hampshire, Chester White, Duroc Jersey, Poland China, and Large Black swine born in Canada and whose sire and dam are registered in their respective sections of the Canadian National Live Stock Records for Swine, or swine of those breeds imported from Great Britain and/or the United States and registered by recognized record associations in those countries are eligible for registration in Canada upon application and the payment of the prescribed fee. Information and application forms for registration and transfer of ownership can be obtained upon request, from the Canadian National Live Stock Records.

THE ADVANCED REGISTRY POLICY

The Advanced Registry Policy, administered by the Canada Department of Agriculture, is designed to enable breeders to select strains or lines of swine which are fertile, have good survival and rapid growth, are efficient in their use of feed, and which will produce market hogs dressing out desirable bacon carcasses.

The test, primarily a progeny test of the sow, is based upon the performance of four representatives from a litter of eight or more sound pigs raised to weaning age. These four pigs are fed at a Government-supervised feeding station and are slaughtered at the approved market weight; then the carcasses are scored according to their ability to meet a standard of excellence in type and quality. Thus a record is made for the sow showing the number of pigs in the litter, age of the four pigs at slaughter, the feed consumed per 100-pounds of gain, and the carcass score. The term "Qualified in A.R." signifies a sow with a carcass score of 75 or more points out of a possible 100, and "Qualified in R.O.P." denotes a sow with a carcass score of 60 to 74. Boars qualify in A.R. after siring three or more qualified litters, each out of a different sow.

A recent analysis of A.R. records has shown that a large proportion of the differences existing in carcass score between litters of one sow and those of another are heritable. Some of the litter-to-litter differences in the characteristics which make up carcass score, such as length, back fat, thickness, and loin area, were also found to be of a heritable nature. The analyses disclosed that maturity (the age at 200 pounds live weight), and feed economy fell into similar categories.

When breeding stock is selected repeatedly on the basis of progeny test, such as is used in A.R., a steady and marked improvement in carcass quality and economy of production should result.

The gilts or boar selected as replacements in the breeding herd should be from high-scoring sows and sired by qualified boars. Females with ancestries of at least three generations of highly qualified sows and boars are exceptionally good prospects for the breeding herd. Since sows and boars qualify solely on the basis of litter sizes and carcass, the actual records of the animals in question should be scrutinized to determine the rapidity of growth (maturity) and feed efficiency with which the A.R. scores were obtained. These characteristics are as important as carcass quality in economical swine production.

Purebred breeders wishing to enter their sows in A.R. should write to the Advanced Registry Board for Swine, Production Service, Canada Department of Agriculture, Ottawa, for application forms and information.

SELECTING REPLACEMENTS FOR THE BREEDING HERD

A good brood sow is one which weans large litters of well-grown pigs that later develop into high-quality market hogs. Such sows should be kept in the herd until there is a noticeable decline in their mothering abilities. Daughters of these sows and of boars that have sired fast-growing "A" pigs make good replacements. Poor-milking or bad-tempered sows and sows whose litters are small or fail to grow rapidly and grade well should be culled from the herd.

The purchase of a few purebreds should not be overlooked in making replacements to the breeding herd. These animals may be used to bring into the herd desirable characteristics which are lacking.

Success and profit in commercial pig production depends, to a large extent, on the kind of boars selected and used. In a sense, the breeding sire is half the herd. Since most of the improvement in swine is first manifest in the pure breeds themselves through improved strains or lines of breeding developed there, the new herd sire presents an excellent opportunity to introduce this new heritable material into a breeder's herd, enabling him to keep up a continued improvement in the productivity of his swine.

Boars should be selected from purebred herds of early maturing Advanced Registry stock. Each should possess plenty of size for age, a strong constitution, and be vigorously active. When using a succession of boars of the same breed in the commercial herd, it is advisable to have them as unrelated as possible.

Individual appearance must be considered

The foregoing discussion of the selection of breeding stock has emphasized the need to select breeding stock on a performance basis, that is, by using Advanced Registry Records and selecting replacement gilts from sows which have raised large litters of "A" grade pigs. Nevertheless, individual type cannot be overlooked. There is considerable variation from pig to pig, even in fairly true breeding strains. Hence particular attention should be paid to straightness and strength of legs and pasterns, and to those characteristics associated with constitution, since these may indicate the wearing abilities of the gilt or sire.

Every sow should be able to nurse twelve or more pigs. Gilts with less than this number of well-placed functional nipples should not be used in the breeding herd. Inverted "nipples", or "buttons" as they are sometimes called, are seldom functional.

ABNORMALITIES FOUND IN SWINE

There are a number of abnormalities found in swine which hamper or completely hinder the normal performance of the animal. While it is doubtful if any of these are completely caused by the heredity of the animal, most are quite definitely inherited to some degree.

Scrotal hernia

Scrotal hernia (this term includes other forms of inguinal hernia) is that form of hernia in which one or more loops of the intestines pass through the abdominal wall alongside the inguinal canal. This is due to a larger than normal opening in the inguinal ring. When these loops fall into the scrotum, a large spongy sac is formed, and the pig is frequently referred to as a "rupture". Inguinal hernia is seldom found in females. This abnormal condition is usually inherited and may be due to two pairs of recessive factors. Castration and further surgery by a veterinarian will produce a normal barrow.

Umbilical hernia

Umbilical hernia is not an uncommon condition and is thought to be heritable, although the exact cause is not known.

Ridglings

Ridglings, or cryptorchids, are male pigs in which one or both testicles have failed to descend to the scrotum. The retained testicle can be removed from the abdominal cavity through surgery by a veterinarian. Failure to do so produces a carcass with a strong sex odour. This abnormality is thought to be heritable, but the exact mode of inheritance is not known.

Hermaphrodites

The term "hermaphrodite" is used to describe pigs possessing various combinations of the male and female reproductive organs. They may include one testicle and one ovary, or two testicles and two ovaries. The testicles are seldom visible, having been retained along with the ovaries. The male organs may develop sufficiently to give a strong male odour to the carcass at marketing time. The external genitalia will usually be slightly malformed and female in character. A true hermaphrodite, of course, contains functional reproductive organs of both sexes and is rarely found in the higher orders of animals. The retained testicles can be removed by a veterinarian.

Although the condition is congenital, the exact cause is unknown. It may be heritable.

Other abnormalities

Closure of the anal opening (called atresia ani), cleft palate, blindness, hairlessness, thickened forelimbs, rigid forelimbs, split ears, hydrocephalus, and "amputated" limbs are other abnormalities occurring less frequently; they are thought to be inherited, although the mode of inheritance is not known. Some of the latter group of abnormalities, such as blindness and hairlessness, may be caused by extremely poor nutrition.

Both the boar and the sow are responsible for most inherited abnormal conditions occurring in the progeny, since they act as "carriers" of these irregular deformities. Boars or sows leaving more than the occasional abnormality should be culled from the breeding herd. Since most abnormalities are, in a sense, kept under cover in the carriers, being due primarily to recessive factors, some inbreeding coupled with ruthless culling will greatly aid in ridding a purebred breeder's herd of such conditions and, at the same time, increase the prepotency of the individual pigs in the herd.

CROSSING AND CROSSBREEDING

Crossing usually refers to the crossing of strains or lines within a breed, and crossbreeding to the crossing of breeds. Many commercial breeders have observed that the crossbred pig is a thrifty animal, growing more rapidly and more economically than the conventional purebred. They have also observed that the crossbred sow is a better milker and mother than the average sow. The extra vigour is based upon a difference existing in the heritable material contributed by the sire and dam of the crossbred. Such a phenomenon is not a myth. It is called "hybrid vigour". Experimental work has shown that most of the lard-type breeds of swine and the new "meat-type" breeds in the United States do exhibit hybrid vigour when crossed. Going a step further and copying from their counterparts in corn breeding, animal breeders have found that this vigour is usually greater when specific strains or lines are used. Some crosses between inbred lines within breeds or between breeds have shown little or no hybrid vigour. As a consequence, some strains within the old breeds and a few new breeds in the United States have been developed on their ability to produce "hybrid" hogs in crossing, rather than for their individual merit as purebreds.

Methods

Crossing or crossbreeding must be systematic to be effective. The conventional plan is that of crossing breeds, or crossbreeding. Either the "crisscross" or "three-breed cross" method may be used. Either method is based upon the use of top-quality purebred sires. The "crisscross" scheme is the simplest: a farmer starts with high grade or purebred sows of one breed; these are mated to a purebred boar of another breed, which he has reason to believe will cross to advantage. The gilts of this cross are saved and mated to a boar of the same breed as the original sows. Boars of the two breeds will be used alternately from this point on.

The three-breed cross involves the use of a boar of a third breed on the first females, and a continued rotation in the use of boars of these three breeds. Introducing more than three breeds is of doubtful value. Unfortunately in crossbreeding, where coloured breeds are involved and the crossbred gilts saved for breeding stock, a fair percentage of coloured hogs will be produced in succeeding generations. Even though these hogs are of the correct bacon type, they may be discounted one grade in the marketing process.

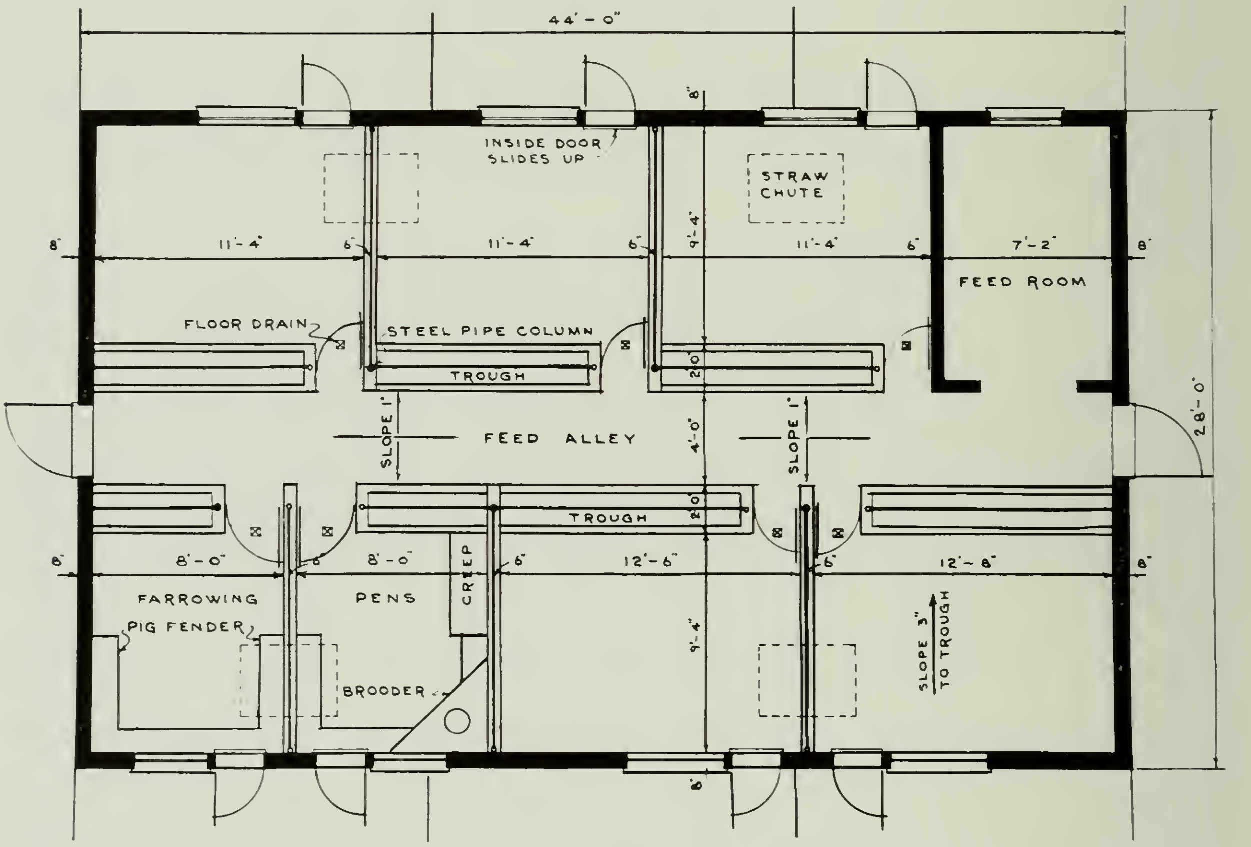
If a breeder wishes to stay within his favourite breed, he may use sires from different strains or lines within the breed. These boars would be used in a similar manner to either of the schemes mentioned above for breed crosses. Since lines within breeds lack the divergence which exists between most breeds, less hybrid vigour can be expected. The possibilities of crossing within our purebreds have not been fully explored. Many more lines which may be called strains, should be developed through mild inbreeding and rigorous selection for high performance.

The buildings used for raising hogs should provide dry quarters, a reasonably uniform temperature, and facilities for easy cleaning.

Drainage

Drainage is essential for dry pens. Hence the site on which the house is placed should be either well drained naturally or drained with field tiles to a suitable outlet.

A drain should be located in each pen inside the house, and the floors should be sloped to the drains. The inside drains are needed to remove the urine produced by the hogs, and to facilitate rapid removal of water when the pens are disinfected or cleaned with a hose. Sometimes open gutters are used instead of buried drain tiles. The gutters are very effective but more unsightly. Provision must be made to remove the effluent from the end of the gutter to a suitable disposal area away from the building.

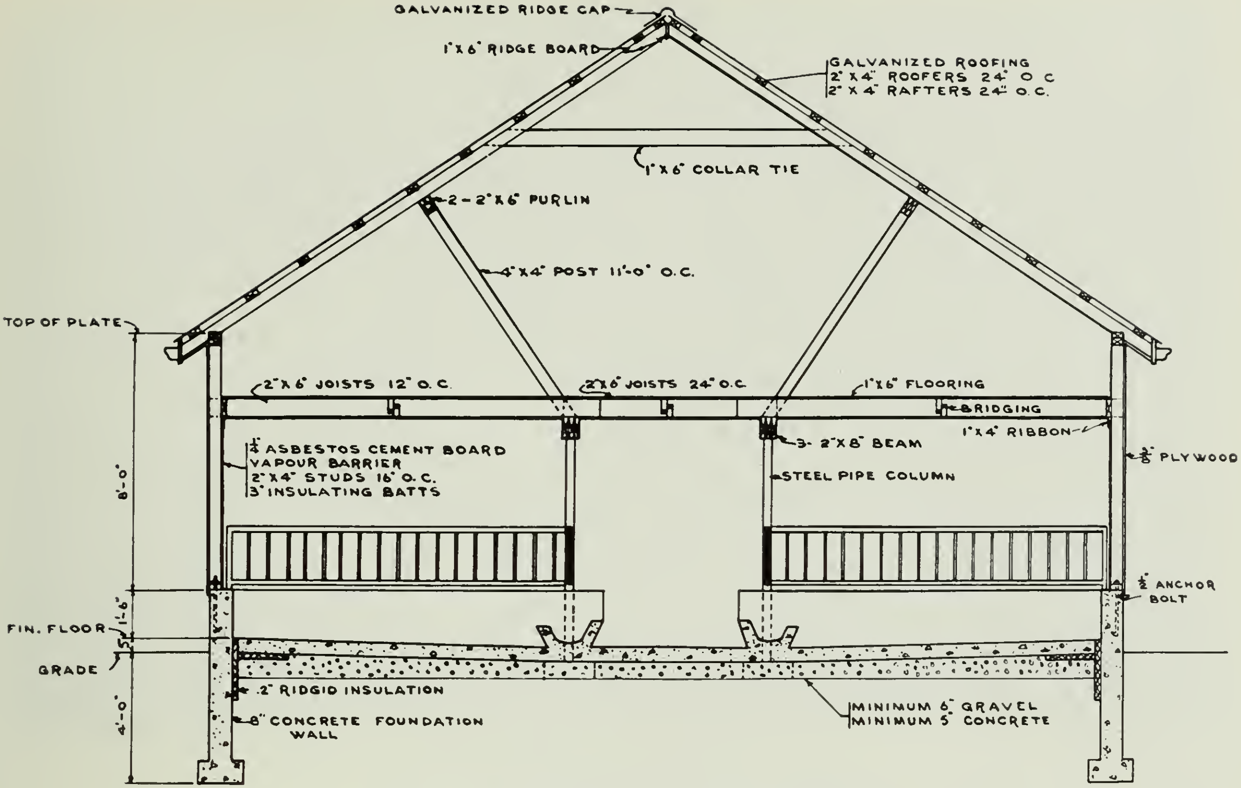


Floor plan—conventional type piggery

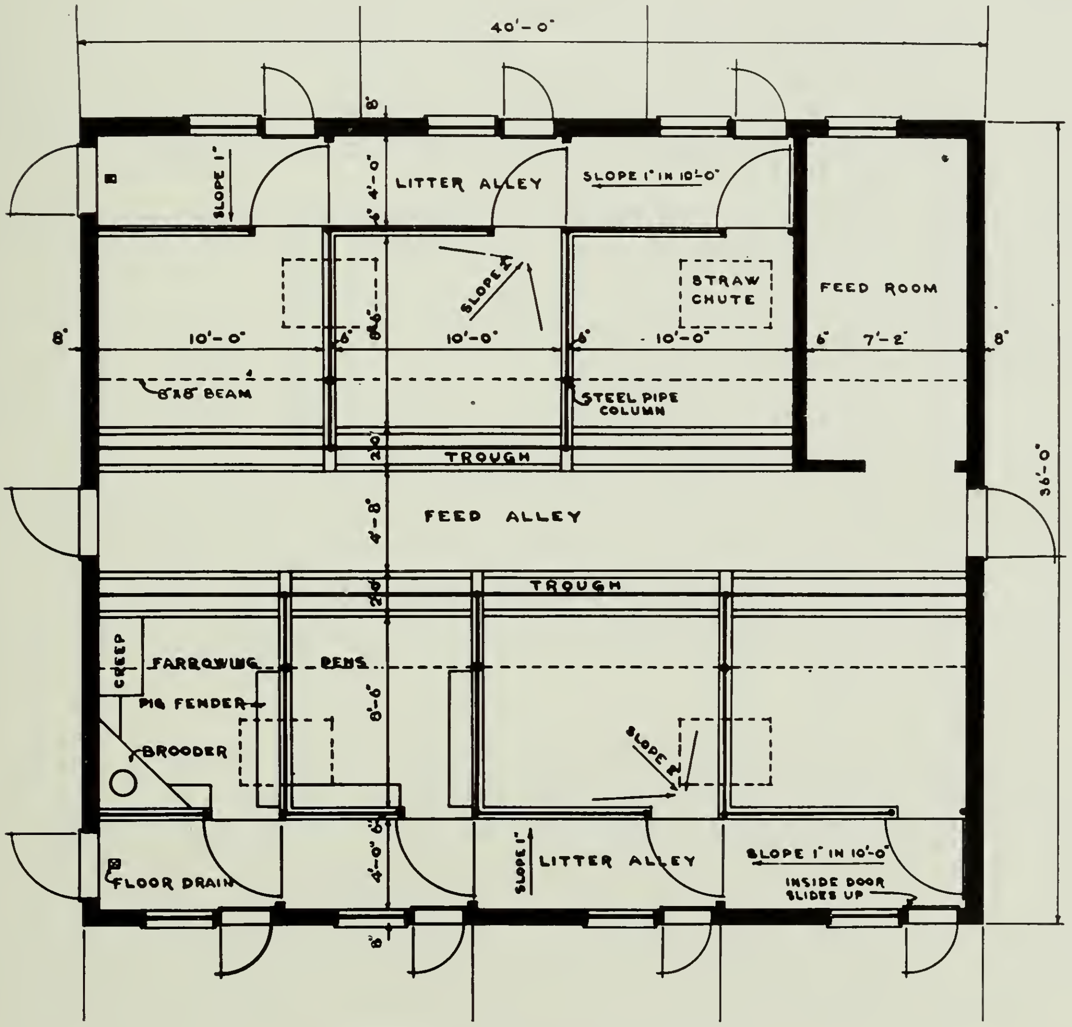
Types of hog houses

There are two main types of permanent houses in use today: the conventional type, and the Danish type. The conventional type has a central feed and litter alley with a row of pens on either side. The Danish system features a central feed alley with litter alleys behind the pens.

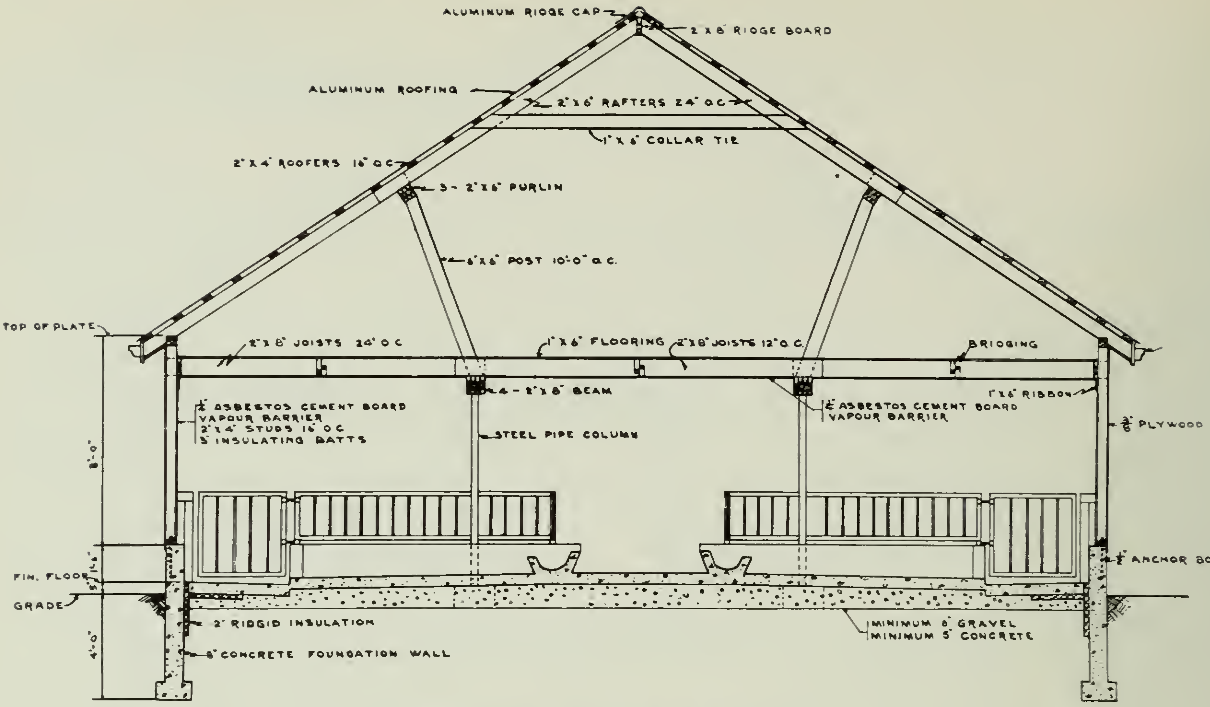
Many hog pens are located in part of a general purpose barn. These pens can be planned in either the conventional or Danish style as shown in the floor plans.



End view—conventional type piggery



Floor plan—Danish type piggery



End view—Danish type piggery

Advantages of the conventional hog house

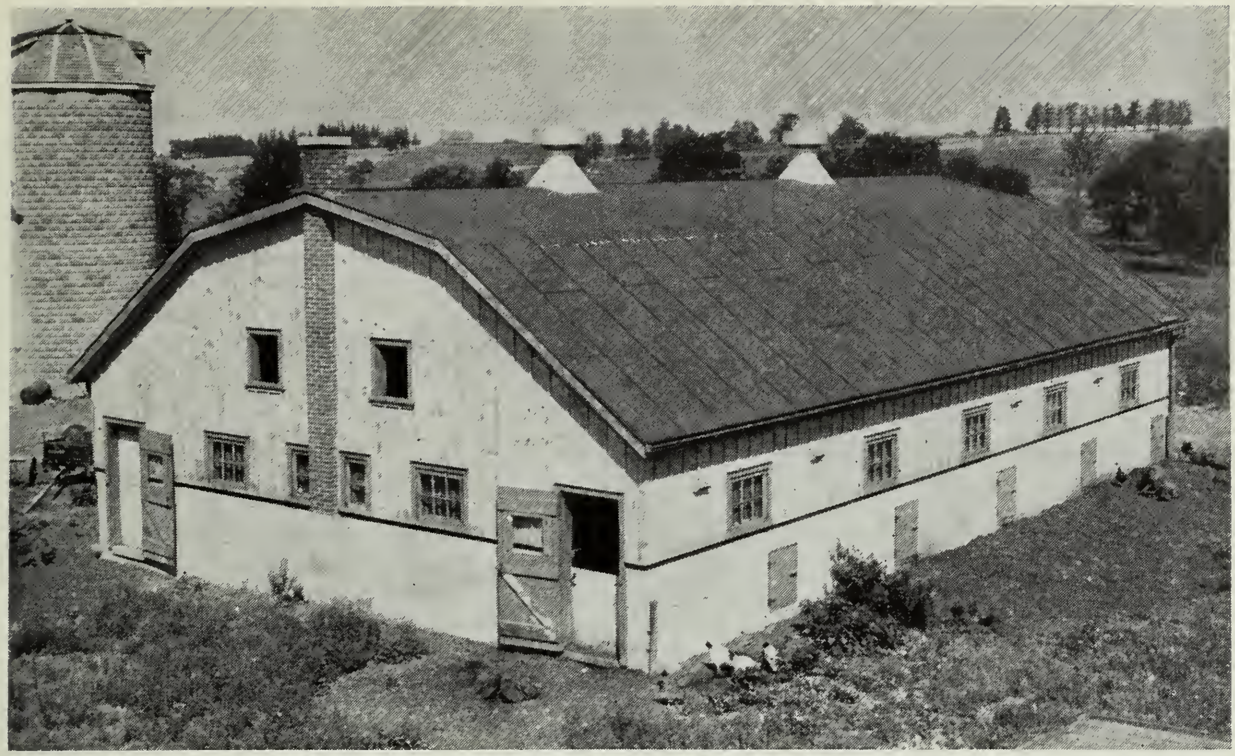
1. Less floor area is required for the same number of hogs; the building can be narrower.
2. Lower sidewalls may be used; this reduces the cost of the building.
3. It is easier to maintain uniform inside temperatures without supplementary heat.
4. Less equipment is required, e.g. litter carrier track, pen partitions, doors.
5. A larger bedded area is available.

Advantages of the Danish hog house

1. It is generally more sanitary, since there is no movement of hogs or litter through the feed alley.
2. Hog producers claim that less labour is required in caring for hogs.
3. The bedded area is away from the cold outside walls.
4. The entire front of the pen can be used for trough space.
5. There is excellent control of hogs when moving them from pen to pen.

Construction materials

When choosing materials for a hog house, the operator must consider their suitability and serviceability. In all probability the pen floors will be wet continually from urine, manure or spilled feed, while the partitions could become an object for the pigs to chew on. Consequently, floors must be constructed from an impermeable material and partitions from material that will withstand chewing. Inasmuch as pens should be disinfected between litters it is advisable to finish the inside in such a manner as to facilitate this operation. If a constant temperature is to be maintained the walls and roof must be insulated. Finally, these objectives should be achieved at the lowest possible cost.



A Modern Piggery

Concrete is recommended for foundations and floors. For pen partitions, concrete curbs 18 inches high, topped with 2 feet of steel-pipe panels are preferred. Solid concrete, concrete masonry, or plank partitions are satisfactory where utmost economy is required. The steel pipe panels are preferred because they do not obstruct light or air movement within the house.

The outside walls may be of masonry or frame construction. In building walls of masonry, it is preferable to use 8 inch lightweight concrete blocks, the cores of which have been filled with granular insulation. Frame-constructed walls should be built on concrete foundations, 18 inches in height. Any insulated frame construction is satisfactory provided a suitable inside sheathing is used. Either asbestos cement board or plywood is recommended for this purpose.

Insulation should consist of 3 inches of mineral wool or its equivalent. Although ceiling insulation is desirable, it is not essential when straw is stored overhead to a depth of two feet. With all types of insulation, a vapour barrier is required on the warm side of the wall to prevent moisture from entering the insulation. In the bat-and-blanket types this vapour barrier is built into the insulating unit. When fill-type insulation is used, it must be installed before the insulating material is placed in the wall.

Simple wood framing is usually practiced in roof construction. Gable roofs with purlins supporting the centre of the rafters, as shown in the end view diagrams, are quite suitable. Sheet metal over widely spaced roof supports, provides the most economical roofing. Galvanized steel is low in first cost; it can be placed over roof supports which are 24 inches apart, but it will require painting every 5 to 10 years. Aluminum roofing costs a little more than galvanized and should be placed over roof supports 16 inches apart. It has good insulating properties, and will never rust.

Ventilation

The primary objective of a ventilation system is to remove the moisture from the piggery and to maintain a minimum inside temperature of approximately 55° F. through a wide range of outside temperatures. In addition to these functions, air purity is maintained and the odour level is reduced. A thermostatically controlled electric exhaust fan is recommended. Fan capacity should be about 25 c.f.m. per 200 pound hog. (A fan is rated by c.f.m.: the cubic feet per minute of air which it will move.) The fan should be located in the south or east of the hog house. Air inlets, each about 4 inches by 10 inches, should be located to direct the incoming air towards the ceiling. They should be evenly distributed around the house with one inlet for every 10 to 15 hogs. No inlets should be closer than 20 feet from the fan.

In areas where electric power is not available, a gravity system of ventilation can be used. Under this system an insulated duct extends from near the floor to above the ridge of the roof. The rate of ventilation is controlled manually by opening and closing a sliding door at the base of the duct. Air inlets are required as described above for an exhaust fan.

Electric fan ventilation is more positive than gravity ventilation and costs no more to install. It gives better control of inside temperature during cold weather, and has a larger capacity for moisture removal in mild weather. Therefore, fan ventilation is recommended where power is available.

Pen sizes

For farrowing pens, a minimum size of 8 ft. by 10 ft. will suffice. Larger pens are preferred because they provide more space for brooder, creep, and guard rails.

Pens for growing pigs vary considerably in size, the common practice being to have pens large enough to accommodate one litter of hogs to market weight. The capacity of a pen is determined by the feeding facilities. For trough feeding, 15 inches of trough per 200 pound hog is required. For self-feeding, four 200 pound hogs per foot of feeder is satisfactory. In terms of floor area, there should be 15 to 20 square feet of floor per market-weight hog.

Feed and bedding storage

In the smaller hog houses, the feed room is usually located at the most convenient place for bringing in feed, and is large enough to hold one or two weeks' supply of feed in bins. In large piggeries, the feed room is centrally located, often having overhead storage bins, grinders, and mixers to eliminate hand labour in preparing the ration.

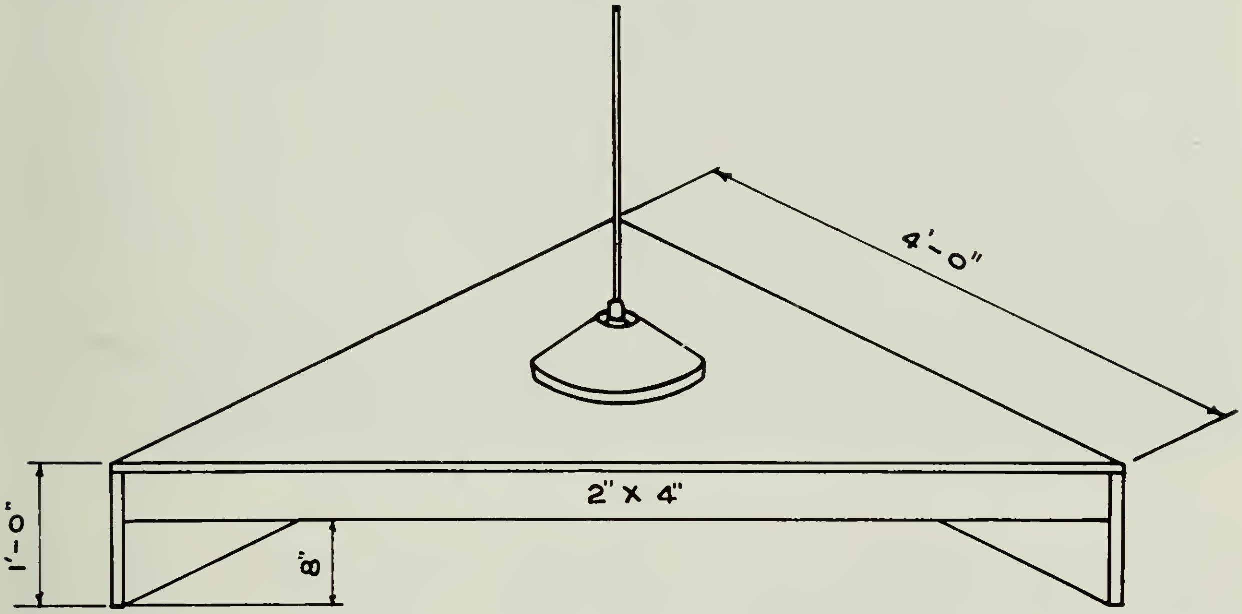
Space for storing bedding is usually provided on the second floor. A pig requires about 500 pounds of straw between weaning time and market weight. If the straw is serving as ceiling insulation also, the entire floor should be kept covered with it during the cold weather.

Pig Brooders

Brooders are frequently required when farrowing occurs during severe winter weather. A popular and very satisfactory brooder is shown on the following page. This triangular hover fits in a corner where it occupies a minimum of space. The heat source, a 150 watt incandescent lamp in a 15-inch reflector, is protected from bedding and animals by a wire mesh with holes not larger than half an inch. The distance between the bedding and the lamp should be 12 inches or more.

If an infra-red lamp is used to furnish the heat it should be mounted in a porcelain receptacle suspended by a chain. The lamp should be protected by a 12 to 15-inch reflector which does not touch the bulb. The chain can be used to adjust the distance between the lamp and the pigs, and in no case should the bulb be less than 18 inches from the backs of the standing pigs.

Either incandescent or infra-red lamps should be shielded by a protective railing which is strong enough to restrain the sow.



A pig brooder

Auxiliary heat

In a well constructed hog house auxiliary heat is required only by new born pigs. Brooders in the farrowing pen provide adequate heating at this time. The installation of a stove or furnace will seldom prove economical for the average producer of market hogs.

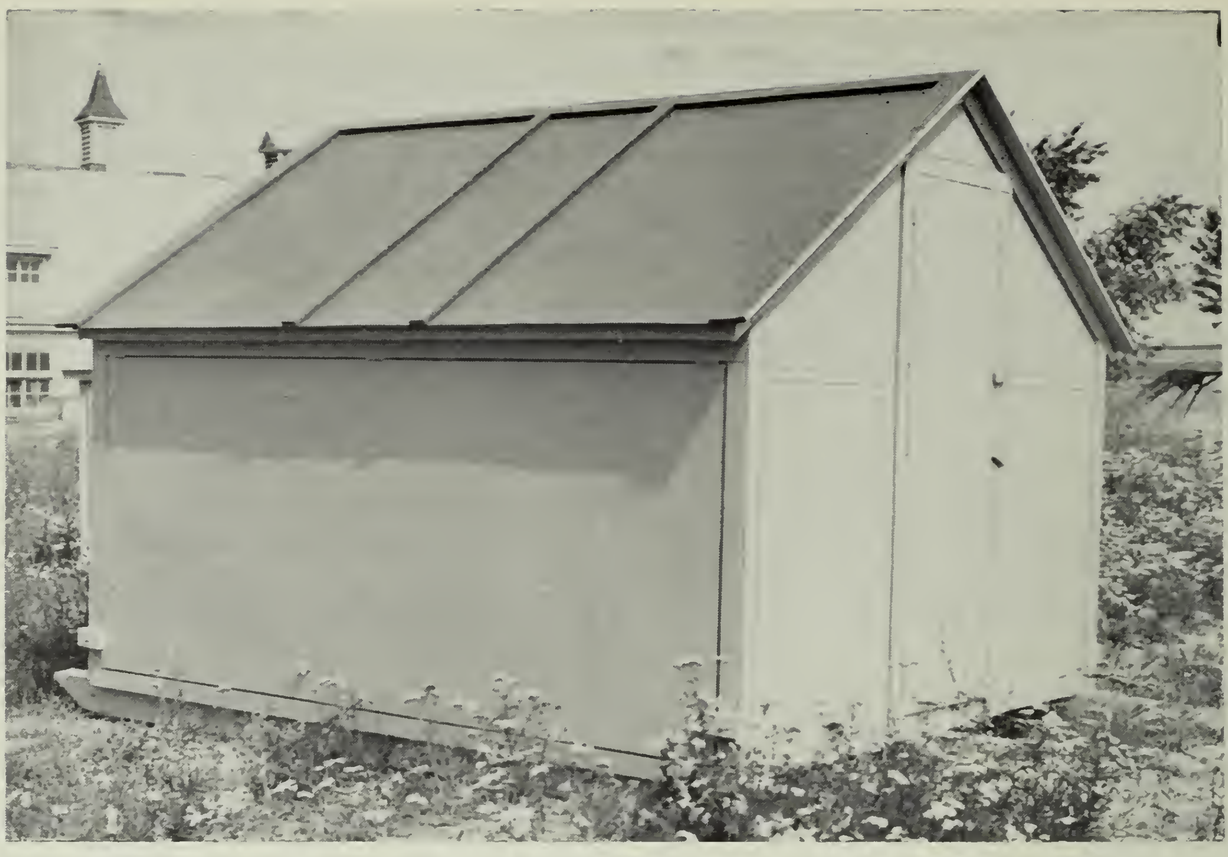
However, many operators of large piggeries, pig hatcheries, and breeders of purebred stock are installing heating units. The extra heat produced makes possible a higher ventilation rate resulting in more moisture removal and drier pens. The heating unit is also an additional guarantee that the inside temperature will not drop below 55°F even in very cold weather.

Colony houses

Colony houses should be rigidly constructed to withstand frequent moving. The house shown on the following page is a very satisfactory type. The sides open out to provide maximum shade and cross ventilation in summer. With the sides closed the house can be used for wintering sows, and with guard rails installed, it can serve as a farrowing pen. The house shown is built of plywood. Metal roofing and siding could be used.

Fences for hog pastures

Permanent fences should be erected around permanent pasture areas, while divisions within the pasture for rotational grazing or dividing lots of pigs can be



A colony house

best achieved with electric fencing. Permanent fencing should be 3 feet high with a strand of barb wire at the top and the bottom. The bottom wire discourages rooting under the fence. Good fencing practice in stretching the wire and bracing corner and gate posts is essential.

FEEDS AND FEEDING

NUTRIENT REQUIREMENTS OF SWINE

As a general rule the nutrient requirements of swine are more exacting than those of cattle for the following reasons:

(1) The pig is a single-stomached animal. Its stomach does not contain cellulose-splitting bacteria, hence it derives little benefit from coarse, fibrous feeds. In addition, vitamins such as riboflavin and vitamin B_{12}, are either not synthesized at all, or else in too small amounts to be of value to the animal. These nutrients must be supplied in adequate amounts in the ration if deficiency symptoms are to be avoided.

(2) The growing pig makes much greater daily gains, relative to body weight, than sheep or cattle.

(3) The body temperature of swine is higher than that of sheep or cattle.

In view of the fact that feed represents about 80% of the cost of raising swine, any real saving that can be made in this item has a definite bearing on the profitableness of the swine enterprise. Consequently, the levels of nutrient intake recommended in this bulletin are those necessary to promote maximum production with a minimum of overfeeding.

A number of factors affect the nutrient requirements of pigs. To provide for the effects of these factors and the variation in feeds, a margin of safety is introduced. Because of the variation in the margin of safety considered necessary, nutrient allowance recommendations are not always in complete agreement. Since the response to a nutrient may depend not only upon the amount of that nutrient present, but also on the relative amounts of the others the concept of a balanced ration is most important in swine feeding.

METHODS OF EXPRESSING NUTRIENT REQUIREMENTS

Nutrient requirements and recommended feeding practices which will meet these requirements are stated in different ways:

(1) They may be related in some manner to body weight. For example, sows should be fed 1.5 to 2.0 pounds of a balanced ration daily per 100 pounds of body weight. Younger sows will require the higher level while older sows will give good results on the lower.

(2) They may be related to the amount of production, the rate of gain, or the number of pigs being nursed. For example, market hogs up to 110 pounds should receive a grain allowance equal to 4% of body weight plus the average daily gain. The nursing sow should receive 1 pound of feed for each pig in the litter, with a minimum of 8 pounds if the litter is less than eight in number.

(3) They may be stated as a percentage of the ration consumed. For example, the ration for market hogs up to 110 pounds should contain 15% to 16% of total protein.

(4) They may be stated as the number of grams, milligrams, or micrograms per pound of ration.

1 pound = 453.6 grams
1 gram = 1,000 milligrams
1 milligram = 1,000 micrograms

A knowledge of the composition of feeds is the basis for the successful formulae mixing

For example, a feeder may decide to increase the riboflavin potency of his ration by adding 0.75 milligrams per pound from one of the three sources available, namely—

(a) skimmilk containing 0.9 milligrams of riboflavin per pound, or

(b) dried skimmilk containing 9 milligrams of riboflavin per pound, or

(c) a riboflavin supplement containing 4,000 milligrams of riboflavin per pound.

When these sources are used

(a) one pound of skimmilk will provide the riboflavin fortification for 1.2 pounds of ration,

(b) one pound of dried skimmilk will provide the same additional riboflavin per pound of final mixture when added to 12 pounds of ration, and

(c) one pound of riboflavin supplement (4,000 milligrams per pound) will provide an additional 0.75 milligrams per pound of the final mixture when added to 5,333 pounds of the ration.

(5) They may be stated as the number of International Units (I.U.) or other units of nutrient required per pound of ration. For example, the pig's requirement for vitamin D is stated as being from 150 to 625 International Units per day, depending upon the weight of the pig. This requirement is met by providing 50 I.U. of vitamin D per pound of feed, or 100,000 I.U. per ton. Field-cured alfalfa hay contains approximately 1,000 I.U. of vitamin D per pound. Hence one hundred pounds of this product will provide the D fortification needed in 1 ton of ration.

Barn-dried or dehydrated alfalfa meal contains less than one quarter of the vitamin D content of the field-cured hay. If such products are used as sources of vitamin A, the vitamin D may be added simply and cheaply by means of irradiated yeast or other concentrates. One type of irradiated yeast contains 64,000,000 I.U. of vitamin D_2 per pound. One pound of this yeast is sufficient to provide the vitamin D fortification in 1,280,000 pounds or 640 tons of feed, whereas one quarter of an ounce will supply 1,000,000 I.U. of vitamin D, or enough for 10 tons of feed.

The problem of mixing such concentrated sources of nutrients into a feed is solved by mixing sufficient quantities of the essential nutrients with a convenient concentrate such as soybean oil meal to form a premix, and then adding the premix to the ration. In actual practice the finished product should contain 100 I.U. of vitamin D per pound, or 200,000 per ton of feed, Inasmuch as premixes are usually added at the rate of 10, 20, or 40 lbs. per ton of feed, it would appear that they carry 20,000, 10,000, and 5,000 I.U. of vitamin D per pound respectively.

Less potent sources of vitamin D are available. Hence the amount which must be added depends upon the potency of the carrier and the number of pounds of premix used in making a ton of finished feeds. The following table indicates the amount of premix to which one pound of vitamin D carrier is added:

Potency of Vitamin D Carrier	Pounds of Premix Added per Ton of Feed		
	10	20	40
64,000,000 I.U. Per pound	1 lb. carrier in 3,200 lbs. of premix	1 lb. carrier in 6,400 lbs. of premix	1 lb. carrier in 12,800 lbs. of premix
16,000,000 I.U. per pound	1 lb. carrier in 800 lbs. of premix	1 lb. carrier in 1,600 lbs. of premix	1 lb. carrier in 3,200 lbs. of premix
4,000,000 I.U. per pound	1 lb. carrier in 200 lbs. of premix	1 lb. carrier in 400 lbs. of premix	1 lb. carrier in 800 lbs. of premix

Premixing 1 pound of carrier in 3,200 pounds of soybean oil meal is a difficult task for the farmer or small feed manufacturer. As a consequence, premixes are now being produced which, when added at the rate of 10 or 20 pounds per ton, provide the correct amounts of essential nutrients. A premix containing 20,000 I.U. of vitamin D and 150 milligrams of riboflavin per pound, added at the rate of 10 pounds to 1 ton of feed, will provide 100 I.U. of vitamin D and 0.75 milligrams of riboflavin per pound of ration.

NUTRIENTS

Water

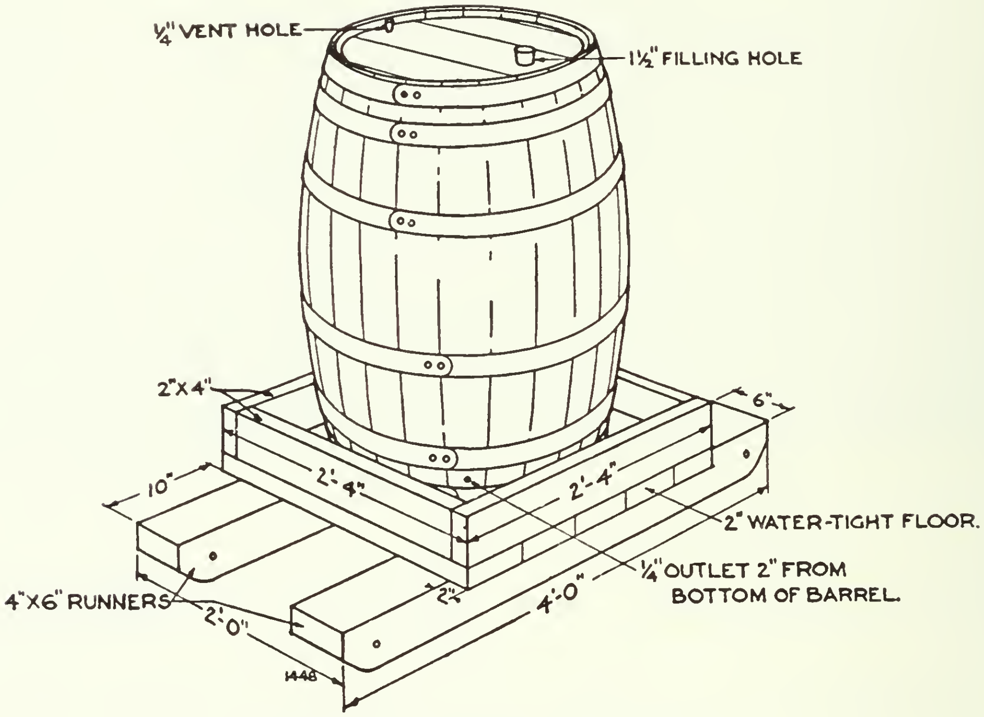
Up to a weight of 200 pounds, a pig's body contains a higher percentage of water than of any other nutrient. In the absence of water, digestion and assimilation of food would be impossible. Water also functions in the elimination of poisons from the body. The pig's water requirement is related to:

(1) – The feed intake, – which in turn is determined by the weight of the pig and the daily gain.

(2) – The type of tissue being developed, – for example, a young, rapidly growing pig develops a tissue containing more water than that of a fattening pig.

(3) – The amount of milk being produced when a sow is nursing a litter, – a condition which can be fully appreciated upon realizing that a dairy cow requires 4 to 5 pounds of water for each pound of milk produced, and that a sow nursing 10 pigs usually produces in excess of 400 pounds of milk in 56 days.

(4) Temperature – A pig will consume more water in hot weather in an attempt to regulate its body temperature. If denied that extra water the feed intake will decline, and the rate growth decrease. Young pigs require about 1 quart or 2½ pounds of water per pound of feed; older pigs need less than 2 pounds. When a pig is forced to consume too much water or water that is too cold its feed consumption is reduced. In trials conducted at the Ontario Agricultural College, best results were obtained when the water being fed was at barn temperature (52°F to 65°F.)



Homemade automatic watering device

The more general use of automatic water-bowls is removing the possibility of water shortage in the pigs ration. Care should be taken to insure that the water is clean and fresh. Pigs on self-feeders will satisfy their needs for water providing the bowls are functioning efficiently. Pigs being slop fed will drink considerable water between feedings with apparently beneficial effects. Water is the cheapest nutrient in the ration.

Carbohydrates

Carbohydrates are the chief source of energy in the swine ration. Fats and surplus protein also contribute to the energy utilized by the pig. The energy-yielding fraction comprises the largest single portion of the swine ration. Energy is needed for maintenance, growth, fattening, reproduction, and lactation. Surplus energy is stored as body fat.

Energy intake requirements are determined by the type and amount of production expected. The lactating sow, the creep-fed pig, and the rapidly growing market hog require highly palatable, high-energy feeds. Hence the percentage of crude fibre in nursing sow rations, creep feeds, and hog growers should be restricted because it is of limited digestibility and dilutes the energy in those feeds of which it forms a part. When the rations fed to dry sows and finishing market hogs are too high in energy, overfatness will result. The available energy content of the ration can be reduced and the tendency to overfatness lessened by increasing the amount of fibre, that is, by using a higher percentage of alfalfa, oats, or wheat bran.

Feedstuffs which are low in crude fibre, such as wheat and corn, have a high energy content. Despite their higher fat content, oats are lower in energy than barley, wheat, or corn because of the high percentage of fibre contained in the hull. Hulless oats and oat groats are high-energy feeds due to the absence of hull.

The energy requirements of pigs of all ages are met by applying the generally recommended feeding rules. A shortage of energy may result in

(a) a slower rate of growth and finishing in market hogs,
(b) less body fat in brood sows,
(c) impaired reproduction, or
(d) a lowered milk production in nursing sows.

Protein

Protein forms by far the greater part of the muscles, internal organs, and connective tissue, hence is essential for growth and development. Proteins are composed of a mixture of amino acids. Actually, a pig requires amino acids in the correct amounts and proportions. The percentage requirement of a number of amino acids is now known, while efforts are being made to determine the requirements of others. Usually, proteins from animal sources are superior to those of plant origin, the protein of soybean oil meal being an exception to this general rule.

The recommended levels of proteins are as follows:

For creep feeds and starters	17%
For pigs from weaning to 110 pounds	15% to 16%
For pigs 110 pounds to market	13% to 14%
For breeding boars and nursing sows	15% to 16%
For dry sows	14%

Quality of protein as well as level of protein is important. Quality of a protein is determined by its content of amino acids. If the proteins used are of good quality from a nutritional standpoint and if the ration is otherwise well balanced, the above protein levels should give satisfactory results. A shortage of protein of the right composition may result in

(a) a reduced rate of growth,
(b) a decreased feed efficiency,
(c) an increased degree of fatness,
(d) dead or weak pigs at birth, or
(e) poor milk production in nursing sows.

Fat

Fat is an energy-rich nutrient. The high percentage found in oat groats (6.1%) and corn (4.0%) accounts for the high energy content of these feeds. The average mixed ration contains sufficient fat. Feeds high in fat should be used when freshly ground, otherwise they tend to become unpalatable as the fat becomes rancid. The type of fat in the feed markedly affects the character of the fat in the hog carcass. Inasmuch as raw soybeans tend to produce low-quality fat, they should not be fed.

Minerals

The pig's requirements for minerals are grouped under three headings:

(1) Sodium and Chlorine,
(2) Calcium and phosphorus, and
(3) Trace minerals.

(1) Salt (Sodium and Chlorine)

The requirements for sodium and chlorine are expressed in terms of common salt (NACL). The committee on Animal Nutrition of the United States National Research Council has stated this requirement in terms of:

(i) Daily recommended allowances in grams for pigs of various weights.
(ii) Grams of salt per pound of ration.

The average mixed ration should contain from ¼% to ½% of added salt. The higher level is recommended when products of animal origin, such as meat meal and fish meal, are used in limited amounts only. A shortage of salt results in a decreased rate of gain and an increased feed requirement per 100 pounds of gain. When the required level of salt is added to a practically salt-free ration, the benefits are very marked; however, further additions show no added benefit. Rations very high in salt (above 5%) are unpalatable and poisoning can result from the intake of excessive amounts of salt. Iodized salt in which the iodine has been stabilized is frequently used to meet both the salt and the iodine requirement of the pig.

(2) Calcium and Phosphorus.

Swine require approximately 0.60% of calcium and 0.40% of phosphorus in the ration. Both the actual amounts and the ratio are important. However, rations containing greater amounts of both elements in ratios differing from those recommended are used. Vitamin D is essential for the best utilization of calcium and phosphorus and should be considered in conjunction with them.

Although cereal grains are not rich in phosphorus, they contain much more phosphorus than calcium. Inasmuch as cereal grains constitute a large fraction of the swine ration and since many supplementary feeds used in swine feeding are high in phosphorus, additional calcium is usually required. Ground limestone (38% Ca) is frequently used as a cheap and efficient source of this mineral. Bone meal (23% Ca, 11% P) is more expensive, but when used alone or in conjunction with limestone, promotes somewhat better calcification.
Deficiency symptoms include

(a) a reduced rate of growth,
(b) a reduced appetite,
(c) lameness and stiffness,
(d) a weakened bone structure,
(e) rickets,
(f) enlarged joints, and
(g) impaired reproduction.

A deficiency of calcium and phosphorus is indicated by rickets in the growing animal and osteomalacia in mature stock. These conditions occur when there is insufficient calcium, and/or phosphorus and vitamin D to promote and maintain proper calcification of the bony structure. In the case of rickets, the bones bend under the weight of the animal; in osteomalacia, bones such as the pelvis, are liable to be fractured.

An example will indicate how these nutrients are calculated in a type ration:

Feedstuff	% in Ration	100 pounds of Ration Supply Calcium (pounds)	Phosphorus (pounds)
Barley	50	.03	.18
Oats	35	.03	.12
Soybean Oil Meal	8	.02	.05
Meat Meal	3	.25	.01
Fish Meal	2	.08	.05
Ground Limestone	¾	.28	—
Bone Meal	¾	.17	.08
Iodized Salt	½	—	—
Total	**100**	**.86**	**.49**

(3) Trace Minerals

Iodine (I), Iron (Fe), Cobalt (Co), Manganese (Mn), and Copper (Cu), minerals required in small amounts, are sometimes deficient in farm rations.

(a) Iodine

Iodine is essential for the prevention of goitre and hairlessness in new born pigs. Hence the brood sow's requirement for iodine is greater than that of the growing market hog. Iodine deficiency can be guarded against by feeding iodized salt in which the added iodine has been stabilized. If a trace mineral premix containing stabilized iodine is being used, plain salt may be fed.

(b) Iron and Copper

The amount of iron required is small and may be easily supplied. Since only a trace of copper is required, the sources of iron in general use carry enough as a contaminant to meet the needs of the pig.

If suckling pigs do not have access to fresh soil the symptoms resulting from a shortage of iron and copper will be observed. This shortage leads to nutritional anemia which can be a very serious problem in nursing pigs. Anemic pigs are pale, particularly in the ears; they become listless, and are subject to conditions such as thumps and digestive upsets.

Anemia may be prevented by supplying supplementary iron to the pigs. Ferrous iron, as found in ferrous sulphate, or reduced iron should be used as they are more readily absorbed than iron in the ferric form. For best results the little pigs should be individually fed reduced iron or ferrous sulphate at three to six days of age, and at weekly intervals thereafter for four to six weeks. An amount equal in size to an aspirin tablet per pig is recommended for each dose. If more convenient, the sow's udder may be swabbed twice weekly with a solution made by dissolving 6 to 8 ounces of ferrous sulphate in a quart of water. This will enable each little pig to obtain a small daily dose of iron at the time of nursing.

Reduced iron and other forms of ferrous iron are being sold in paste and tablet form. They are easily administered and should be used according to directions.

A relatively simple method of preventing anemia is to provide each pig of the nursing litter, once a week, with a six-inch square sod on which has been sprinkled one teaspoonful of ferrous sulphate dissolved in a quart of water. This solution is sprinkled on the earthen side of the sod. In order to guard against infestation of parasites, sods used for this purpose should be procured from areas where pigs have not been running.

The above recommendations, while making possible good performance in nursing pigs, will not prevent some decline in blood hemoglobin levels. The feeding of iron should be continued until pigs are eating from the creep or trough, at which time the hemoglobin level will begin to return to normal. Access to soil where practicable, dosing with ferrous sulphate or reduced iron, and encouraging pigs to eat at the earliest possible age will meet the iron and copper needs of the nursing pig and very largely solve the problem of anemia.

Trace mineral premixes containing iodine, iron, copper, manganese, and cobalt are available. They have been tested in Canada to a limited extent only. A great deal more work of a precise nature must be done before definite recommendations concerning their use can be made. To date, evidence regarding the value of cobalt in swine rations and of extra iron in sows' rations is conflicting. The benefits accruing from the addition of trace minerals may be small. Even so, their inclusion might prove to be a sound investment, particularly since their cost seldom amounts to more than ½ of 1% of the cost of the ration.

Vitamins

Vitamins are required in small amounts. They are divided into two main groups, namely —

(1) fat-soluble vitamins, and
(2) water-soluble vitamins.

The only fat-soluble vitamins apt to be in short supply are vitamins A and D. The chief water-soluble vitamins of concern to swine nutritionists are riboflavin, pantothenic acid, niacin and vitamin B_{12}.

(1) Vitamin A.

Vitamin A can be supplied either as carotene (provitamin A) or as preformed A. Carotene is found in green forages, dehydrated and well-cured legume-grass mixtures, grass or legume-grass silage, and corn. Good pasture is an excellent source of carotene. On the other hand, barley, oats and wheat have a very low carotene content. Vitamin A is present in feeding-type oils which are sold on the basis of a guaranteed vitamin A potency. More recently, synthetic vitamin A has become available in stabilized form. One I.U. of true vitamin A is equivalent to 2½ I.U. of carotene. Inasmuch as Canadian rations are composed mainly of grains, and since pasture is used to a limited extent only, vitamin A deficiency will occur unless rations are adequately fortified.

A pig's vitamin A requirement increases as it grows older and as the pounds of feed per 100 pounds of body weight decreases. Hence, it is high for boars, pregnant gilts and nursing sows. For pigs in these classes, 600 I.U. per pound of growing ration, and 2400 I.U. per pound of breeding-stock ration should be added. If vitamin A is supplied in the form of carotene the additions should be 1500 I.U. and 6000 I.U. per pound respectively.

A shortage of vitamin A may result in

(a) poor growth,
(b) increased susceptibility to infection, particularly to infections of the respiratory tract,
(c) impaired reproduction, or
(d) the birth of weak or dead pigs.

The birth of dead, partly resorbed pigs is often an indication of vitamin A deficiency. In severe cases pigs may be born without eyeballs. Impaired vision, blindness, and muscular degeneration are also symptoms of severe vitamin A deficiency. If not guarded against, vitamin A deficiency can cause heavy economic losses under Canadian conditions.

High-quality pasture is an excellent source of carotene (provitamin A). Grass and grass-legume silage, fed at a rate of 3 pounds per pig per day, will meet the vitamin A requirements of brood sows. There is a growing trend towards the use of grass silage in pregnant sow rations.

Field-cured alfalfa hay of excellent quality contains approximately 30,000 International Units of carotene per pound. When fed at the rate of 5% of the ration (100 pounds per ton), it will meet the requirements for a grower (2,700,000 I.U.) but not for a sow ration. For this reason farmers should not depend upon their own roughage as a source of vitamin A unless they are certain that it is of

Type and potency of carrier.	Requirement per ton of feed For Grower (pounds)	For Sow Ration (pounds)
Fair quality legume-grass mixture (sun-cured) 15,000 I.U. of carotene per pound	200	800
Excellent quality legume-grass mixture (sun-cured) 30,000 I.U. of carotene per pound	100	400
Dehydrated legumes and grasses 60,000 I.U. of carotene per pound	50	200
Dehydrated legumes and grasses 120,000 I.U. of carotene per pound	25	100
Dehydrated legumes and grasses 240,000 I.U. of carotene per pound	12½	50
Feeding fish oil 1,200 I.U. of A per gram	2½	10
Feeding fish oil 2,400 I.U. of A per gram	1¼	5
Feeding fish oil 7,200 I.U. of A per gram	5⁄12	1⅓
Stabilized Synthetic A 4,000 I.U. per gram	⅔	2⅔
Stabilized Snythetic A 10,000 I.U. per gram	¼	1

high quality. Yellow corn, if fed as the principal part of the ration, will provide swine with ample amounts of vitamin A.

One ton of hog grower will require 1,200,000 I.U. of vitamin A or 3,000,000 I.U. of carotene if it is to meet the vitamin A needs of the pig. To supply the higher requirements for reproduction, brood sow rations should contain four times these levels. The amount of concentrate which must be added depends upon the potency.

After mixing with feeds, vitamin A and carotene undergo destruction by oxidation. To minimize this destruction, mixed feeds should be as fresh as possible when fed.

(2) Water-soluble vitamins

Certain members of the vitamin B complex are the most important water-soluble vitamins in swine nutrition. The feeder will be interested in those which might be borderline in rations mixed from natural feedstuffs.

(a) Riboflavin

Riboflavin deficiency results in slow growth, reduced appetite, and lessened feed efficiency. Riboflavin-deficient pigs have a rough hair coat and secretions around the eyes. In more pronounced cases the pigs develop a sebaceous exudate over the back and sides, have stiffened limbs, and develop diarrhoea.

The riboflavin requirements of swine have been tentatively set at 0.84 milligrams per pound of hog grower and 1.25 milligrams per pound of brood sow ration. Average farm grains contain approximately 0.60 milligrams per pound. For best results, therefore, grains should be supplemented with riboflavin-rich feedstuffs or riboflavin concentrates.

Skimmilk, buttermilk, and whey in the proportions usually fed to swine are excellent sources of riboflavin. If sufficient skimmilk or other dairy products are added to provide the necessary protein, the riboflavin requirements will be met. Dried skimmilk, condensed fish solubles, dehydrated alfalfa meal, and dehydrated green cereal plants are good sources of riboflavin. When added to rations as carriers of other nutrients, they will contribute about one half of the extra riboflavin needed in sows' rations.

To supply sufficient riboflavin from these products would prove a greater expense than can be justified. In actual practice, extra riboflavin is obtained most economically from riboflavin concentrates. The cost of adding 0.75 milligrams of riboflavin per pound of feed amounts to less than 20¢ per ton.

(b) Pantothenic acid

A shortage of pantothenic acid results in slow growth and lessened feed intake. Deficient pigs show signs of stiffness, and in severe cases develop a characteristic goose-stepping due to nerve degeneration. Other symptoms include a brownish secretion around the eyes and scurfy, thin hair.

The requirement for pantothenic acid is stated as 3.7 milligrams per pound of ration, but is higher when low-protein, high-corn rations are fed. Characteristic deficiency symptoms have been observed in hogs raised on such a ration. However, if a ration is otherwise balanced by using Canadian feedstuffs, the pantothenic acid content should be adequate. Trials in Canada and the United States have shown that no benefit is obtained from adding pantothenic acid to a well-balanced ration.

(c) Niacin (Nicontinic acid)

Niacin deficiency symptoms include loss of weight, diarrhoea, vomiting, roughness of hair and skin and, upon autopsy, lesions in the stomach and intestines. Insufficient niacin is recognized as a possible cause of enteritis. However, enteritis is not always due to niacin deficiency, though high levels of niacin, along with thiamine, riboflavin, and pantothenic acid, are often used as part of the treatment for this disease.

Fishmeal, condensed fish solubles, corn distillers' solubles, dried brewers' yeast, liver meal, and wheat mill by-products are good sources of niacin. Dehydrated grasses and legumes, meat products, barley, oats, and soybean oil meal are fair sources. Of the commonly used grains, barley is the richest in niacin, while corn contains less than other cereal grains. Under Canadian conditions a deficiency of niacin seldom occurs.

(d) Vitamin B_{12}

The full importance of vitamin B_{12} under field conditions in Canada remains to be determined. Vitamin B_{12} has a vital role in a number of body functions including the formation of red blood cells. A shortage of vitamin B_{12} leads to reduced growth, anemia and extreme nervousness. This vitamin is required in minute amounts, 5 micrograms per pound of ration being adequate. It is stored by the body and actual deficiency is not often observed. Vitamin B_{12} is found only in products of animal origin and of microbiological fermentation. Products such as fish solubles, fish meal, and meat meal are good sources of vitamin B_{12}; milk is only a fair source. The increased use of protein-rich feedstuffs of plant origin, such as soybean oil meal, could result in too low an intake of vitamin B_{12}. In such cases it can be readily supplied by concentrates produced by microbiological fermentation. These products are sold on the basis of a guaranteed potency of vitamin B_{12}.

Vitamins and unknown factors

The pig's requirements for thiamine, pyridoxine, and choline have been determined and the requirements for other factors known to be essential are being studied. As more precise information on requirements is available, the formulation of more nearly balanced rations becomes possible. Canadian basal feeds — barley, oats, and wheat, along with mill by-products are intrinsically sound. The extent and amount of fortification needed are the subjects of continuing investigation. The extra nutrients required should be supplied, if possible, from natural sources providing this is economical. However, it is sometimes more economical to add nutrients produced by microbiological fermentation or by synthetic processes.

Research has indicated the presence in certain feeds of unidentified factors required in trace amounts. Among the sources of these factors are liver meal, fish solubles, other meat products, and milk by-products. The place in swine rations of the unidentified factor will have to be determined when more information is available.

Antibiotics

The fact that certain antibiotics have growth-promoting or growth-permitting properties is one of the important nutritional discoveries of recent years.

A large field has been opened up, but many unanswered problems remain. The following points are moderately well proven:

(a) The response to antibiotic additions to otherwise well-balanced rations is variable. The causes of the variation are not all known.

(b) The response to antibiotics is greater if pigs are subject to digestive disturbances. Hence, pigs which are scouring or pigs which are runts, provided the stunted condition is not due to a disease such as rhinitis, will respond more readily than healthier pigs.

(c) Antibiotics vary in their effectiveness and also in the response which they produce under different conditions. Aureomycin, terramycin, and penicillin are about equal in effectiveness. Bacitracin and streptomycin are less effective in growth promotion at ordinary levels.

(d) The full effects of antibiotics are only obtained if swine are full fed and have sufficient water. The greater part of the increased gain obtained from antibiotic feeding is due to increased feed consumption.

(e) Young animals show a greater response to antibiotics than older animals. For this reason antibiotics are most useful in creep feeds and pig starters.

(f) Antibiotics have no beneficial effects if fed to breeding stock. Their use in brood sow rations is not recommended.

(g) It is impractical to attempt to raise the antibiotic levels of a sow's milk by feeding, though they can be transmitted through the milk.

(h) Opinions vary as to the probable effects of antibiotics on carcass quality. The highest-quality carcasses are produced by rapid growth from weaning to 125 pounds, and slower growth from then until finishing time; therefore, if high quality carcasses are being sought, it will perhaps be advisable to discontinue antibiotic feeding and reduce feed consumption at a live weight of 125 pounds. It is quite probable that certain strains with a marked tendency to leanness can be fed antibiotics to market weight and yet produce quality carcasses.

(i) Antibiotics are not a substitute for sound nutrition and sound management. If properly used, they offer promise of a more efficient swine production program.

(j) The recommendations for antibiotic feeding expressed in grams per ton are as follows:

For grower	9-10 grams per ton.
For creep feeds and starters	18-20 grams per ton.
For runt pig feeds—highly fortified	36-40 grams per ton.

Antibiotics are available in the form of special feed supplements and as antibiotic B_{12} mixtures. In both forms they are sold on a guaranteed potency basis. Supplements containing intermediate amounts usually cost less per unit. Quite frequently, antibiotic mixtures being sold without a B_{12} guarantee contain an appreciable amount of this vitamin.

Feed dealers may purchase their antibiotic requirements from wholesale suppliers. Farmers who mix their own feeds should contact their local feed mill or retail feed dealer.

CHARACTERISTICS OF FEEDS

Feeds used in swine rations are divided into two broad categories, namely

(1.) basal feeds used primarily as sources of energy, and

(2.) supplemental feeds fed primarily on account of their protein, mineral, vitamin, or antibiotic contents to make good the deficiences in the basal ration.

(1) Basal Feeds

(a) Barley

Under Canadian conditions, barley is the basal feed with which all other feeds should be compared. High-quality Canadian barley is an excellent feed for growing and finishing bacon hogs. It is higher than corn in protein (12.0 vs. 8.6) and in crude fibre (5.4 vs. 2.0), but lower in Total Digestible Nutrients (77.7 vs. 80.1). For this reason barley requires less protein supplement than corn. As a single feed, barley is more efficient for swine production than oats. Barley and wheat are about equal in value in the swine ration. For best results, barley should be ground medium-fine. It is not quite as palatable for newly weaned pigs as other farm grains, but this slight lack of palatability is no drawback in the growing-market-hog ration.

(b) Oats

Oats are widely used in the swine ration, their chief limitation being a high fibre content (11%). However, they may constitute up to one third of the grain mixture. If the percentage of oats is not above this level, they have the same feeding value as heavier grains. If used at levels above one third of the grain mixture, they increase the time needed to reach market weight and also the feed required per 100 pounds of gain.

Oats may constitute a higher percentage of the ration of dry sows. They add bulk to the ration and partially offset the tendency to overfatness.

For best results, oats should be finely ground. At times oat hulls are the cause of digestive disturbances in suckling and newly weaned pigs. It is advisable, in feeding young pigs, to remove the hull in the preparation of oat groats or by sifting the chop.

Any decision regarding the best ratio of oats to barley in the swine ration will depend upon the following factors:

(i) The age of the pigs, — oats should not constitute more than one third of the ration of growing and fattening pigs under average conditions.

(ii) The quality of the oats available, — heavy, plump oats will give much better results than lighter weight oats with a high percentage of hull.

(iii) The relative price of oats and barley, — if both grains must be purchased this factor may determine, to a very great extent, the relative amounts used.

(c) Corn

Corn is a very palatable feed and is widely used for swine feeding. It is lower in protein than barley, oats, and wheat. In general, corn requires more supplementation than the other grains in order to correct its nutrient deficiencies. Corn is a high-energy feed, and if used as the sole basal grain, results in overfat carcasses. Providing the deficiencies of corn are taken into account in ration formulation, it can be used to advantage in Canadian swine rations when justified on the basis of price.

(d) Wheat

Wheat is a high-energy feed and tends to promote overfinish. Western wheat is generally higher in protein than oats or barley, hence requires less supplementation. Wheat which is degraded on account of being frozen may be used in mixtures with good results, providing an allowance is made for its somewhat higher fibre content. Ontario winter wheat is lower in protein than hard spring wheat so will require more supplementation. Wheat should be ground medium-fine for best results. Rolled wheat may be used also, especially in creep feeds. Fine grinding results in pastiness.

(e) Buckwheat

The woody hulls of buckwheat constitute from 18 to 20% of the seed. Buckwheat has about the same percentage of fibre as oats; it is lower in protein and has only about one half the fat content. As a feed for hogs it is less satisfactory than barley, oats, wheat, or corn. Because of its lower feeding value and lack of palatability, it should not constitute more than one third of the grain mixture. White-skinned breeds of hogs, fed buckwheat, may develop an intense itchiness of the skin, especially when exposed to direct sunlight. Buckwheat middlings may be used as a replacement for wheat middlings in feeding swine.

(f) Rye

Rye is somewhat unpalatable as a feed, but when mixed with more palatable feeds its value is about equal to that of barley, especially for fattening pigs. Rye containing ergot should be avoided. Rye middlings may constitute up to 20% of the basal feed in swine rations.

(g) Oat Groats

Oat groats, the product remaining when the hulls of oats have been removed, are of particular value in feeding young pigs. They are higher in protein, fat, and energy than the whole oat and are very palatable. Whole oat groats or hulless oats are frequently used in creep feeds and in pig starters where palatability is important.

(h) Wheat Bran

Wheat bran is used in swine rations when bulk is required. Its inclusion in the ration of the newly farrowed sow is a recommended practice. Bran may be added to the ration of dry sows being fed on self-feeders and to the finishing ration of pigs which are tending to become overfinished. A mixture containing 65 lbs. of barley, 25 lbs. of bran, and 10 lbs. of protein-mineral-vitamin supplement is recommended for finishing hogs that tend to become overfat on the regular ration.

(i) Wheat shorts and Wheat middlings

Wheat shorts and wheat middlings are frequently used as a part of the basal ration. Shorts consist of fine particles of bran, germ, and a small proportion of flour separated during the milling process. Middlings are finer than shorts; they contain less of the bran and germ and more low grade flour hence are lower in fibre. Both feeds are highly palatable so may be used in swine rations, particularly in rations for brood sows and newly weaned pigs.

(2) Concentrates

Basal feeds are incomplete in themselves so, for best results, require supplementation to correct their deficiencies. The kind and amount of supplementation required is dependent upon the nature and extent of the deficiencies. Although their composition varies, the ones most commonly used are usually deficient in amount and quality of protein. The protein supplements used most frequently are as follows:

(a) Skimmilk or buttermilk

Skimmilk and buttermilk contain approximately 37% protein on a dry-matter basis. In addition, both are good sources of readily available energy, riboflavin and calcium. Because of the quality of its protein, skimmilk has a higher value than an equal amount of nutrients in other feedstuffs, providing it is used in the correct proportions with farm grains. One quart of skimmilk (2½ pounds) added to 1 pound of mixed grain will give a 16% grower (based on 90% dry-matter). Mixed grain and skimmilk, pound for pound, will produce a 14% ration entirely satisfactory for finishing hogs. If milk is fed above these levels, full returns will not be obtained from the nutrients contained in it. Skimmilk is deficient in vitamins A and D. Pasture in the summer and fish oil in winter will supply these nutrients and prevent vitamin A and D deficiencies. Dried skimmilk and dried buttermilk are sometimes used as sources of protein. In general they are more expensive than other sources of protein, hence are used to a limited extent.

(b) Meat meal

Meat meal is the dry-rendered and/or open-kettle-rendered residues from animal tissues, suitable for animal feeding, and containing not less than 50% of crude protein. It is free from blood except for such traces as may occur unavoidably in good factory practice.

Meat meal is a protein of animal origin. It is a good, but variable, source of vitamin B_{12}. The inclusion of meat meal containing bone reduces the amount of calcium and phosphorus supplement needed. In swine rations, meat meal is more valuable than tankage.

(c) Tankage

Tankage is similar in composition to meat meal except that it may contain 35% of blood. This lowers its palatability and nutritive value. High-grade tankage may be used as a part of the protein concentrate in swine rations, though meat meal is more generally recommended.

(d) Fish meal

High grade fish meal contains from 60 to 70% of protein of excellent quality. It is a good source of calcium, phosphorus, riboflavin, and vitamin B_{12}. It is usually expensive, hence its use is restricted to rations for young pigs.

(e) Soybean oil meal

Soybean oil meal (protein 44%) is a by-product from the production of soybean oil. If properly heat-treated to render all of the amino acids available, soybean oil meal is an excellent protein supplement for swine, approaching in quality the proteins of meat, fish and milk. Soybean oil meal is a fair source of riboflavin, niacin, and pantothenic acid. When soybean oil meal constitutes a large part of the protein, rations will require more supplementation with vitamins and minerals, including trace minerals, than rations containing a high proportion of protein of animal origin. Because of its quality and availability, soybean oil meal is widely used in swine protein supplements and is replacing part of the meat meal and fish meal previously used in such rations. It has replaced linseed oil meal as the standard plant protein in swine rations.

(f) Linseed oil meal

Linseed oil meal (protein 35%) is less valuable than soybean oil meal as a source of protein. It may be used in combination with other protein-rich feedstuffs.

Feeds used primarily as vitamin supplements.

Feeds such as dehydrated legume and grass meals, fish oils, dried distillers' solubles, dried fermentation solubles, brewers' yeast, and irradiated yeast are fed primarily for their vitamin content.

(a) Dehydrated legume and grass meals

These products are usually sold on the basis of their carotene content. If a dehydrated product is used, care must be taken to provide extra vitamin D. While generally superior to sun-cured products, dehydrated legume and grass meals are quite variable in composition depending upon

(1) the mixture of legumes and grasses used,
(2) the stage of cutting, and
(3) the amount of destruction during storage.

Dehydrated meals, in addition to supplying carotene, are carriers of calcium, riboflavin, niacin, pantothenic acid, and choline.

(b) Sun-cured alfalfa hay and alfalfa meals

Sun-cured alfalfa hay and the meal derived from it are extremely variable in quality. The depth of the green colour provides an approximate, but somewhat inaccurate, guide to its carotene content. Only high-quality hay and meals should be used. The sun-cured product, sometimes cheaper in price than the dehydrated product, can be used in dry sow rations. Poor quality meals should not be included in swine rations. High-quality alfalfa hay can be made available to brood sows in racks. If the hay is of good quality sows will derive appreciable amounts of carotene, vitamin D, and B complex vitamins from it.

(c) Dried corn distillers' solubles

Dried corn distillers' solubles contain about 27% protein of only moderate quality. When available, they are used as a source of members of the B complex.

(d) Dried fermentation solubles

Fermentation solubles, a by-product of the production of butyl alcohol and other fermentation products, are used as a source of riboflavin. When fortified with niacin, pantothenic acid, and choline, they are sold on the basis of a guaranteed potency. These products are readily available and provide common means of adding one or more of the B complex vitamins apt to be needed in swine rations.

(e) Yeast

Dried brewers' yeast is a rich source of certain water-soluble vitamins. It contains 49% protein of fair quality. The members of the B complex found in yeast can be purchased at a lower price in fermentation solubles. However, the ease with which yeast may be purchased makes its use practical for inclusion in the ration of newly weaned pigs or of runt pigs.

(f) Whey and dried whey

Whey and whey products are valuable chiefly as suppliers of vitamins. They are relatively low in protein (12% on a dry-matter basis), but the protein is of good quality. If whey is used in swine feeding, extra protein from such sources as soybean oil meal should be used to increase the total protein in the ration. The poor results sometimes reported with whey feeding are due to a shortage of protein. Whey and whey products are good sources of riboflavin which may be increased by certain fermentation processes.

(g) Fish solubles

Fish-solubles are an excellent source of vitamin B_{12}, also members of the B vitamin complex and other unknown nutritional factors. Although their protein content is of good quality fish-solubles are not pleasant to handle.

(h) Irradiated yeast

Irradiated yeast, a convenient source of vitamin D, is sold on the basis of a guaranteed vitamin D potency. Vitamin D is quite inexpensive.

(i) Irradiated sterols as sources of vitamin D

The controlled irradiation of sterols results in the formation of vitamin D. There are a number of such products on the market which should be purchased on the basis of their guaranteed vitamin D potency.

(j) Fish oils are sold as carriers of vitamins A and D. On account of the low cost of vitamin D, fish oils are often priced on their vitamin A content. As a vitamin A carrier, they compete on the market with dehydrated grass and synthetic A compounds.

Mineral supplements

(a) Reduced iron

Reduced iron is a handy source of iron for the prevention of anemia. It is extremely stable. Care should be taken to avoid over-dosing since it is caustic in nature.

(b) Ferrous sulphate

Ferrous sulphate is a cheaper source of iron than reduced iron. On standing, the iron changes gradually to ferric iron which is less valuable. If a number of litters are being treated per year the use of ferrous sulphate will result in some saving.

(c) Ground limestone

High-quality ground limestone is mostly calcium carbonate and contains about 38% of calcium. It is frequently the only additional source of calcium used in swine rations. Calcitic limestone is preferable to dolmitic limestone because the latter is high in magnesium.

(d) Bone meal

Feeding bone meal and steamed bone meal contain approximately 23% of calcium and 11% of phosphorus. In special bone meal, the amounts of calcium

Individual treatment — the most effective way of preventing anemia

and phosphorus per 100 pounds may be higher if the percentage of protein is reduced. In addition to calcium and phosphorus, bone meal contains a number of trace elements. Slightly better calcification is obtained from feeding bone meal or bone meal and limestone than from limestone alone.

(e) Other calcium and/or phosphorus carriers

There are a number of products, such as defluorinated rock phosphates and colloidal clays, available as sources of calcium and/or phosphorus. They may be used provided the fluorine they contain does not contribute more than 0.014% of fluorine to the final ration. A mineral intended for use in swine rations should not contain more than 0.45% fluorine.

(f) Trace mineral premixes

Premixes of mineral carriers designed to supply iron, copper, iodine, cobalt, and manganese, have been produced for use in swine rations. They are usually added at the rate of 2 to 4 pounds per ton.

(g) Antibiotic and antibiotic-vitamin B_{12} concentrates

Sources of aureomycin, penicillin, and terramycin are available to the feed trade. Usually, they are the residues from antibiotic manufacture and are standardized to definite potencies. Unless otherwise guaranteed, antibiotic concentrates contain appreciable, though not guaranteed, amounts of vitamin B_{12}. Antibiotic—vitamin B_{12} concentrates are available and carry guaranteed amounts of both antibiotic and vitamin B_{12}. From a knowledge of the amount of antibiotic and/or vitamin B_{12} recommended for the particular ration being formulated, it is relatively simple to calculate the pounds of antibiotic or antibiotic – vitamin B_{12} supplement that must be added to a ton of ration.

RATIONS

(1) For farms with an adequate supply of skimmilk or buttermilk.

(a) For breeding boars, nursing sows, and market hogs up to 125 pounds live weight:

Farm grains containing ½% of salt	1 pound
Skimmilk or butter milk plus fish oil	1 quart or 2½ pounds

(b) For dry sows and market hogs 125 to 200 pounds live weight:

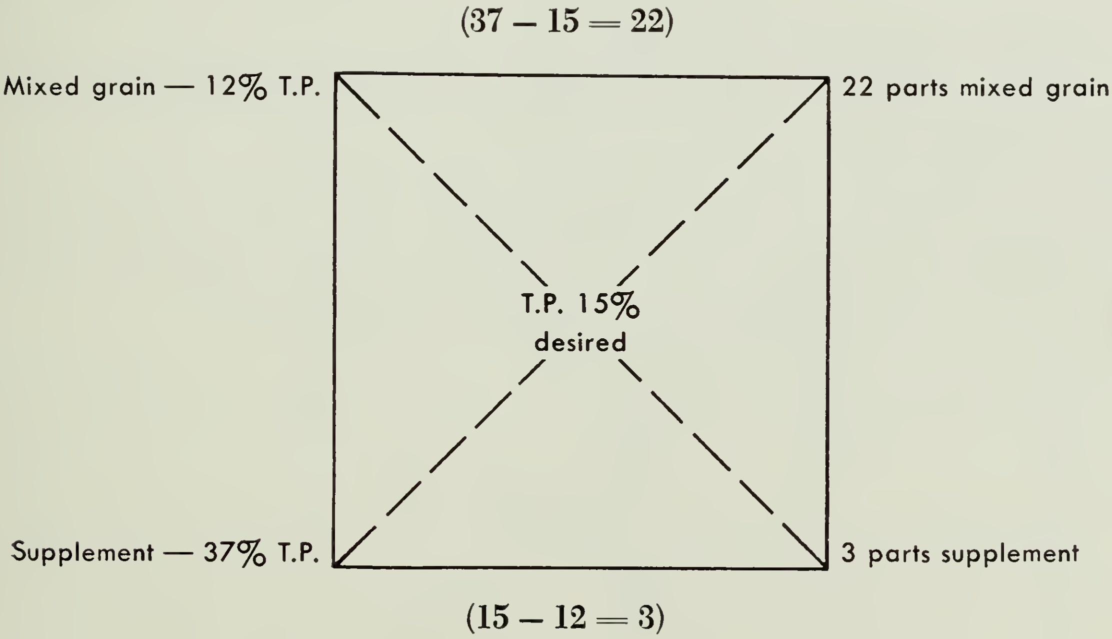
Farm grains containing ½% of salt	1 pound
Skimmilk or buttermilk	1 pound

plus fish oil if the pigs have not access to good pasture

(2) For farms with no milk or a limited supply only.

(a) Balanced rations are made by combining basal feeds and protein-mineral-vitamin supplements in the correct proportions to give the percent of protein required. The use of Pearson's Square is helpful in this connection.

For example, when producing a balanced ration containing 15% total protein from mixed grain (12% protein) and a supplement containing 37% protein the calculations are made as follows:

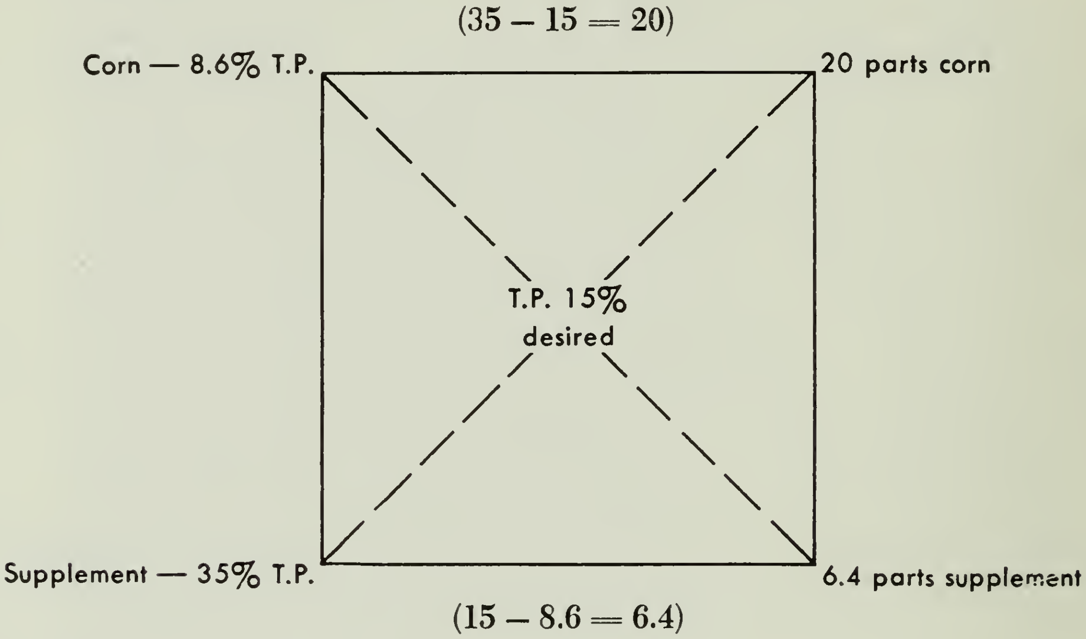


22 Parts mixed grain	88%
3 Parts supplement	12%
25 Parts	100%

The calculations may be checked in the following manner:

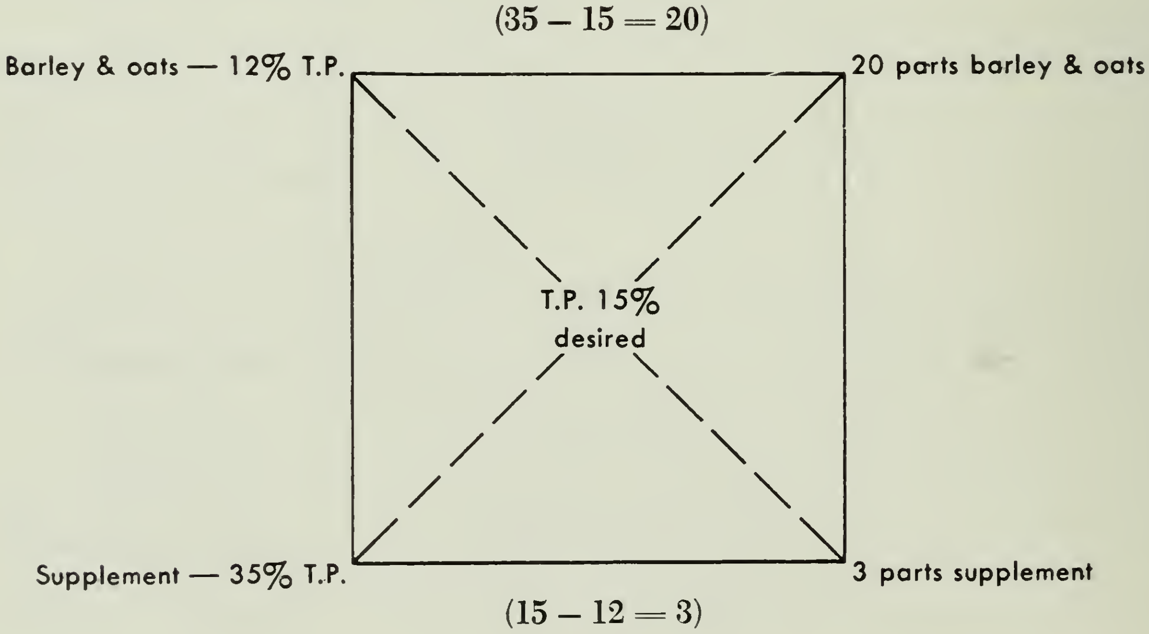
88 lbs. of 12 per cent grain supply yields	10.56 lbs. of protein
12 lbs. of 37 per cent supplement supply yields	4.44 lbs. of protein
100 lbs. of ration supply yields	15.0 lbs. of protein

Two more examples will serve to illustrate the effect of percentage protein in the basal feed on the amount of supplement required.



20	Parts corn	76%
6.4	Parts supplement	24%
26.4	Parts	100%

If corn (8.6% protein) and the 35 per cent protein supplement are used, the corn and supplement must be combined in the ratio of corn 76 per cent: supplement 24 per cent.



20 Parts grain	87%
3 Parts supplement	13%
23 Parts	100%

If barley and oats (12 per cent protein) and a 35 per cent protein supplement are used, the grain and supplement must be combined in the ratio of grain 87 per cent: supplement 13 per cent.

Many farmers depend upon protein-mineral-vitamin supplements for mixing with their home-grown or purchased grain. There are a number of reliable supplements on the market which, by regulation, must contain at least 35% protein.

By mixing 85 parts of oats and barley with 15 parts of 35 per cent protein-mineral-vitamin supplement, a grower containing 15 to 16 per cent of protein will be produced. If corn is used, the proportions are 75 parts of corn to 25 parts of protein supplement for a 15 to 16 per cent grower.

By mixing 92 parts of oats and barley with 8 parts of 35 per cent supplement the finishing ration containing 14 per cent of protein will result. If corn is used, the proportions are 80 parts of corn to 20 parts of protein supplement for a 14 per cent finishing ration.

The quality of the complete ration will depend upon the feeding value of the basal feeds and quality of the supplement. In general, higher-quality grains and supplements should be used in the rations of brood sows, creep-fed pigs and those up to 100 pounds live weight.

Protein-mineral-vitamin-antibiotic supplements

Feeders may be interested in mixing their own supplements. The actual ingredients which are used will depend upon

(i) the stage of growth of the pig,
(ii) the degree of vitamin and antibiotic fortification required,
(iii) the availability of ingredients, and
(iv) the cost.

In actual practice it is most convenient to mix the ration in two stages. The supplement or concentrate is mixed first and then combined with the grains and other basal feeds to make the complete ration.

Protein-Mineral-Vitamin-Antibiotic Supplements

Supplement No.		I	II	III	IV
Soybean Oil Meal	1†	470	480	480	165
Meat Meal		235	275	300	190
Fish Meal		120	70	—	47
Dehydrated Alfalfa Meal		—	—	—	470
Ground Limestone		60	35	50	47
Feeding Bone Meal		30	70	100	47
Iodized Salt	2†	40	35	50	23.5
Feeding Oil	3† 4†	15	15	10	12
Antibiotics*		54 g.***	31 g.	33 g.	—
Vitamin B_{12}*		54 mg.***	31 mg.	33 mg.	—
Riboflavin**		5 g.	—	—	5 g.

The total in all cases is approximately 1,000 pounds which includes antibiotics, vitamin B_{12}, and riboflavin carriers. These weights will be variable depending upon the potency of the carriers used.

* As an antibiotic-vitamin B_{12} supplement.

** As a riboflavin supplement.

*** g. = grams mg. = milligrams

1† Linseed oil meal may replace up to one third of the soybean oil meal in supplements III and IV when justified by price per unit of protein.

2† Plain salt may be used when trace minerals containing stabilized iodine are added.

3† Synthetic vitamin A and vitamin D sufficient to supply 1,200,000 I.U. of vitamin A and 120,000 I.U. of vitamin D per ton of ration may be used. Amounts four times as great are recommended for brood sows.

4† High-quality, dehydrated grass-legume mixtures plus synthetic D may replace the feeding oil. The product should be capable of supplying 3,000,000 I.U. per ton of grower, or 12,000,000 I.U. per ton of sow ration when the amount included in each ton of grower is not more than 100 lbs. or in each ton of sow ration, not more than 300 lbs.

RATION BUILDING

By using the above supplements, balanced rations may be made as follows:

Amounts of Basal Feeds and Supplements for Swine Rations

(1) STARTER	1660 lbs. Basal Feed:	340 lbs. Supplement I
(2) GROWER	1710 lbs. Basal Feed:	290 lbs. Supplement II
(3) FINISHER	1800 lbs. Basal Feed:	200 lbs. Supplement III
(4) PREGNANT SOW	1600 lbs. Basal Feed:	400 lbs. Supplement IV
(5) NURSING SOW	1700 lbs. Basal Feed:	300 lbs. Supplement I

It is false economy to use supplements in amounts lower than recommended above.

The following tables indicate the proportions of selected basal feeds and supplement that may be mixed to produce satisfactory rations:

TABLE I – CREEP FEED AND PIG STARTER

Corn and/or Barley (Ground Medium-Fine)	400 lbs.
Wheat and/or Corn (Ground Medium-Fine)	460 lbs.
Oat Groats (Ground or Rolled)	400 lbs.
Wheat Middlings	400 lbs.
Supplement No. 1	340 lbs.
Total	2,000 lbs.

TABLE II — PIG GROWER (Weaning to 110 Pounds Live Weight)

Barley and/or Corn (Ground Medium-Fine)	800 lbs.
Oats (Ground Fine)	400 lbs.
Wheat and/or Corn (Ground Medium-Fine)	510 lbs.
Supplement No. 11	290 lbs.
Total	2,000 lbs.

TABLE III — PIG FINISHER (110 Pounds to Market Weight)

Barley and/or Corn (Ground Medium-Fine)	900 lbs.
Oats (Ground Fine)	500 lbs.
Wheat and/or Corn (Ground Medium-Fine)	400 lbs.
Supplement No. III	200 lbs.
Total	2,000 lbs.

TABLE IV — DRY SOW RATION

Barley and/or Corn (Ground Medium-Fine)	300 lbs.
Oats (Ground Fine)	850 lbs.
Wheat and/or Corn (Ground Medium-Fine)	450 lbs.
or	
Wheat Middlings	400 lbs.
Supplement IV	400 lbs.
Total	2,000 lbs.

The nursing sow ration will be the same as the starter except that 400 pounds of finely ground oats will replace an equal quantity of oat groats.

PASTURES FOR SWINE

Good pastures properly rotated serve three main purposes:

1. They guard against possible nutrient deficiencies. Rapidly growing pasture, especially pasture containing a high percentage of legumes, is a good source of carotene, B vitamins, calcium, and protein. When good pasture is used, the amount of vitamin fortification and protein can be reduced.

2. The use of pastures provides exercise and, in the case of breeding stock, enables them to be maintained in a thrifty condition with less grain feeding.

3. Properly rotated pastures aid in disease and parasite control. They can be employed to advantage in reducing feed costs and improving the swine programs, particularly where large numbers of pigs are kept. Swine on pasture should be provided with fresh water, shade, and a balanced ration. To prevent rooting, the pigs should be rung before being placed on pasture.

The following crops may be used for grazing:

CROP	RATE OF SEEDING	TIME OF SEEDING	TIME OF USE
Rye	6 - 8 pecks	Late summer or Early Fall	Late Fall, Early Spring
Alfalfa and Brome Grass	6 - 8 pounds 3 - 6 "	Spring	Spring and Summer
Rape	4 - 5 pounds	Early Spring to Midsummer	Summer to Early Fall
Soybeans	2 bushels	Spring to Early Summer	Late Summer
Oats and Sudan Grass	1 bushel 10 - 15 pounds	Spring	Midsummer
Permanent Pasture Including Ladino Clover	—	Spring	Spring and Fall

The amount of pasture which pigs will eat depends upon its composition and stage of maturity. Generally, pigs prefer legumes to grasses. Since mature forages are unattractive to pigs, pasture should be clipped and new growth allowed to develop. Pigs on poor pasture should be fed in the same manner as those receiving no pasture.

ROOTS FOR SWINE

Roots are classed as a succulent feed because of their high water content. They are highly digestible and tend to be slightly laxative; thus they serve to overcome constipation, a serious condition in brood sows.

Mangels and sugar beets are the roots most commonly fed to swine. The fodder beet, developed in Europe, is much higher in dry matter than mangels and is being used to replace up to one-half of the grain in swine rations. Roots are an expensive source of nutrients.

Surplus or cull potatoes, may be fed to swine. They should be steamed or boiled and the water used in the cooking process discarded. For best results, boiled potatoes should not replace more than one-half of the grain ration. In order to correct the deficiencies of potatoes, they should be fed in a ration containing a liberal amount of skimmilk or other protein supplement. Potatoes and skimmilk mixed in equal proportions by weight, or potatoes and a 35% protein-mineral-vitamin supplement mixed in the ration of 12 cwt. of potatoes to 100 pounds of supplement, may replace a portion of the grain mixture with good results. In general, it requires from 350 to 450 pounds of potatoes to replace 100 pounds of grain. Raw potatoes are unpalatable for swine and should not be fed.

GRASS SILAGE FOR SWINE

In winter, properly made grass silage will serve many of the functions of pasture. Four pounds of grass silage per day for market hogs and ten pounds per day for dry sows will give good results and effect some grain saving. If fed at higher levels, market hogs will make unsatisfactory gains and sows may produce weak pigs. Frozen or mouldy silage should never be fed. Corn silage is not a satisfactory feed for swine.

RULES FOR SWINE FEEDING

(1) Sows

(a) A dry sow should be fed daily from 1.5 to 2.0 pounds of a balanced ration for each 100 pounds live weight. A small sow which may still be growing requires the larger amount per 100 pounds body weight; the mature sow will give good results on the lower amount. The bred sow should be kept in moderate condition by being fed a well-fortified, moderately bulky ration.

(b) A nursing sow should be fed the amount which she will clean up promptly at three feeds daily. It will range between 10 and 15 pounds of dry meal per day.

The amount of feed required for a sow nursing two litters per year will vary from 2,500 to 3,500 pounds depending upon

(1) the amount of pasture used,
(2) the size of the sow,
(3) the gains made by the sow,
(4) the condition in which the sow is maintained, and
(5) the size of the litters.

(2) Boars

In order to maintain a boar in a satisfactory condition, he should be fed a balanced ration in amounts equal to 1.5 to 2.0 per cent of his body weight.

(3) Growing and finishing market pigs.

The daily feed requirement of a growing pig depends on its size and rate of gain. The daily feed consumption of pigs of the same weight may vary considerably. There is also a wide variation in the rate of gain made by pigs of a given weight. Hence, for the most efficient utilization of feed, growing pigs should be full fed but not overfed.

As a general rule, a growing market pig should be fed daily an amount of a balanced ration equal to 3¾% to 5% of its body weight. The higher percentage will apply in the case of younger pigs; the lower one with pigs nearing market weight.

In general, 3 pigs will consume slightly less than one ton of feed from weaning to market weight. If pigs are from an inefficient strain, more feed will be required, but with an efficient strain, one ton of feed will prove sufficient for 3¼ to 3½ pigs from weaning at 30 pounds to a market weight of 200 pounds.

In slop-feeding, use equal volumes of liquid and meal for younger pigs, and somewhat less liquid for older pigs. For best results pigs should have access to fresh water, preferably in water bowls. If the liquid is skimmilk or buttermilk, the weight of meal used per pig should be reduced to allow for the fact that 10 pounds of skimmilk or buttermilk have the same dry matter as one pound of grain ration. Whey contains approximately one half the dry matter of skimmilk.

FACTORS AFFECTING CARCASS QUALITY

A high percentage of carcasses of preferred weights are degraded because of overfatness. Since excess fat is expensive to produce and commands a relatively low price when processed, it is in the Ontario farmer's long-term interest to increase his percentage of A grade carcasses. The quality of a carcass is determined by a number of factors, the principal ones being type and degree of finish. Both type and finish are influenced to a very great extent by breeding. Hence breeding stock should possess good length, flat sides, a smooth well-laid-in shoulder, and full hams, otherwise carcasses of acceptable type cannot be expected. At present, under-finish is not a problem of any consequence.

According to a survey covering the gradings of Ontario hogs, feeding has an even greater influence than breeding. It was shown that farmers using balanced rations obtained a much better grade than those using other feeds. A ration consisting of skimmilk and farm grains gave the best results. Heavy feeding of corn or whey, when not properly supplemented, resulted in low quality hogs. Rations which were unbalanced, particularly with respect to protein, produced fatter carcasses, while an excess of energy or a shortage of protein tended to promote overfatness.

The marketing of hogs, particularly barrows, at weights slightly lower than 200 pounds will increase the percentage of premium carcasses. In certain strains, individuals which finish very rapidly are apt to be overfat. This tendency may be overcome in part by slowing down the rate of growth after the pig reaches 125 pounds. The highest percentage of A grade carcasses will be produced when pigs are grown quickly from weaning to 125 pounds by the use of a palatable, low-fibre, high-energy, balanced ration, and then changing them to a bulkier finishing ration. Wheat bran or oats may be used to add bulk to the ration.

SUPPLEMENTARY FEEDING OF LITTLE PIGS

From time to time, it may become necessary to supplement or to replace the brood sow in order to raise the litter. If at all possible, the new-born pigs should get some colostrum from their dam or other newly farrowed sow. When the problem is one of raising a very large litter, it is advisable to split the litter into two groups and allow each group to nurse at separate times.

If little pigs nurse every two hours at first and less frequently thereafter, a sow will provide them with all the milk they require for the first week. Supplementary feeding may be required after that age is reached.

Orphan pigs or those requiring supplementary feeding can be fed cow's milk with satisfactory results. For the first few days the milk should be fed at body heat. The pigs require at least five feedings daily until they are two weeks old; less frequent feedings will suffice as the pigs become older. Whole milk from a low-testing cow is most satisfactory. If possible, the milk should be diluted with 1/3 lime water; to this is added corn syrup at the rate of 2 tablespoonfuls per quart of milk to increase the sugar, and enough cream to restore the original fat content. Vitamin A and D deficiency can be guarded against by adding a few drops of fish oil daily. Anemia prevention should be practised by the use of reduced iron or ferrous sulphate. Orphan pigs should be encouraged to eat a pig starter at as early an age as possible. This habit can be stimulated by reducing the amount of milk as the intake of creep feed or starter is increased. If the pig starter is nutritious and well-balanced, the milk may be discontinued as soon as the pigs are well started.

MILK REPLACEMENTS

The possibility of raising pigs by artificial means is of interest to research workers and feeders. It offers the prospect of weaning a higher percentage of the pigs born, also the possibility of producing heavier little pigs. Under well-controlled conditions, variable, but at times, good results have been obtained. There are a number of definite drawbacks to the method under farm conditions, namely

1. the inability of the feeder to control the diseases and digestive upsets which occur,

2. the amount of labour, and
3. the cost.

On the average farm, the use of milk replacements is not a satisfactory alternative to a good brood sow.

An extension of the studies on synthetic sows' milk has resulted in the development of commercial milk replacements. These products contain dried milk, dried whey, lard, minerals including trace minerals, a high level of the essential vitamins, and antibiotics. Milk replacements have been designed to enable the feeder to raise young pigs, which are removed from their dam at two to three days of age. To keep the cost as low as possible and to obtain best results with a program based upon a milk replacement, the pigs should be provided with a highly palatable creep feed at an early age.

There are too many unanswered problems in connection with a program of weanling production, based on the use of milk replacements, to warrant its general recommendation. If such milk replacements are commercially available, their use is feasible either for large litters needing supplementary feeding or for orphan litters.

THE USE OF HIGHLY FORTIFIED FEEDS FOR RUNT PIGS

Runt pigs require special care, otherwise they will result in a loss. The adoption of approved breeding, feeding, and management practices will reduce, but not eliminate, the problem of the runt pig.

Rations well fortified with vitamins, particularly vitamin A and certain members of the vitamin B complex, and also antibiotics have given excellent results when fed to runt pigs. The high level of fortification ensures that the pig receives an adequate amount of vitamins and antibiotics in a smaller-than-average daily feed intake. After runt pigs have begun to eat a normal amount of feed, a marked improvement will be observed in their condition rate of gain. The following ration could be termed a runt pig feed:

A satisfactory type of self feeder

Ground Barley and/or Ground Corn (Medium)	400	lbs.
Ground Wheat and/or Ground Corn (Medium)	460	”
Oat Groats (Ground or Rolled)	400	”
Wheat Middlings	400	”
Soybean Oil Meal	160	”
Meat Meal	80	”
Fish Meal	40	”
Ground Limestone	20	”
Feeding Bone Meal	10	”
Iodized salt	15	”
Feeding Oil (400 D–2400A)	5	”
Antibiotic Supplement #	8-10	”
B Vitamin Supplement # #	2	”
Total	2,000	lbs. (approx.)

# To supply approximately 40 grams of antibiotic.

# To supply approximately 4 grams of riboflavin, 4 to 8 grams of pantothenic acid, and 12 to 25 grams of niacin.

Antibiotic and B vitamin supplements can be purchased commercially to supply the recommended levels.

There are also antibiotic – vitamin supplements containing vitamins, A, D, B complex, and antibiotics which may be used in place of the last three ingredients when added in sufficient quantities to provide the following amounts.

Vitamin A	4,000,000 I.U.
Vitamin D	400,000 I.U.
Riboflavin	4 grams
Pantothenic Acid	4-8 grams
Niacin	12-24 grams
Antibiotic	36-40 grams

After runts have “straightened away”, they should be changed gradually to the regular ration.

THE USE OF SELF-FEEDERS

Self-feeders, if operating efficiently, can reduce the labour required in hog production. However, all self-feeders do not work satisfactorily. Often a simple self-feeder works just as efficiently as a more complex one.

Self-feeders should be checked daily to make certain that they are operating correctly. It is important to guard against the mechanical loss of feed since such loss will increase the quantity required per hundred pounds of gain.

Self-feeders are most useful for pigs being creep fed, for growing market hogs, and for sows nursing litters. Their use for finishing market hogs and brood sows may result in overfatness. This tendency can be overcome by the inclusion of bulky feeds such as wheat bran, ground oats, or high-quality alfalfa meal in the ration.

To avoid the effects of too much competition at the feeders, sufficient space should be provided to allow at least one-quarter of the pigs in a pen to eat at one time. Self-feeders being used outside should be equipped to turn rain. The platform underneath the feeder should be long enough to provide a solid footing for the pigs.

MANAGEMENT

Importance of Size of Litter in Determining Profit

A good hog producer strives to raise the greatest possible number of pigs per sow annually. Although the management involved in accomplishing this objective actually commences with the selection of breeding stock, the capitalization on such selection is controlled, to a considerable extent, by the feeding and management of the boar and the sow previous to breeding.

The feeding and care of the sow following conception and during the nursing period, together with the feeding and management of the litter from the time it is weaned until ready for market, largely determine the profitableness of the enterprise.

The extra pigs represent the profit

Over a four-year period, the Ontario Live Stock Branch conducted a demonstration swine production project with fifty hog producers co-operating by keeping records on all phases of production. These men were considered to be average producers in their respective communities. The following tables compiled from information provided by them will serve to indicate the importance of the size of litter in determining profit.

These figures reveal the returns per sow per year on the basis of the number of pigs raised per year. Attention is called to the net returns which are calculated after all charges are made for investment, labour, and feed. It should become obvious that a sow raising less than thirteen pigs per year is not a profitable one. Under existing prices of feed and market prices of carcasses, it is safe to suggest that a sow must raise at least twelve pigs per year before any reasonable profit over cost of production can be anticipated.

EFFECT OF NUMBER OF PIGS WEANED PER SOW PER YEAR

Pigs Weaned per Sow	Net Returns per Enterprise				
1.	1947-48	1948-49	1949-50	1950-51	4 yr. Average
Less than 13	$ 668	$ 692	$327	$ 767	$ 618
13 to 16	$ 918	$1187	$599	$1276	$ 993
More than 16	$1031	$1348	$802	$1916	$1263
	Pounds Concentrates Fed per Live Cwt.—Total Herd				
2.	1947-48	1948-49	1949-50	1950-51	4 yr. Average
Less than 13	486 lbs.	471 lbs.	498 lbs.	455 lbs.	479 lbs.
13 to 16	441 lbs.	443 lbs.	447 lbs.	430 lbs.	441 lbs.
More than 16	435 lbs.	389 lbs.	411 lbs.	419 lbs.	414 lbs.
	Returns per $100 Feed				
3.	1947-48	1948-49	1949-50	1950-51	Average
Less than 13	$153	$170	$134	$174	$157
13 to 16	$175	$173	$148	$181	$168
More than 16	$181	$188	$157	$194	$180

Care of the Boar

During the summer season, a boar should have the run of a good pasture lot, and receive sufficient feed to keep him in vigorous, breeding condition, but not fat. In winter, a comfortable, dry pen, large enough to permit freedom of movement should be provided. It is important that the pen be cleaned regularly and kept free from dust. Lice must be controlled on the herd sire, otherwise they will spread to all of the sows in the herd. Regardless of the season, a boar should be obliged to take exercise every day. Boars on pasture require shelter. If pasture is not available, green feed may be supplied in the pens. Feeding should be carried out in accordance with the recommendation contained in the "feeding" section of this bulletin.

In the Breeding Season

During the breeding season, it is advisable to increase the boar's feed allowance. Since many boars go off feed at that time, feeds should be as palatable as possible.

A young boar should not be used for breeding until he is from eight to nine months of age, nor too extensively during his first breeding season. He should not be used more than once a day for five days in the week, nor permitted to serve a sow more than once. It is a mistake to allow a boar, especially a young one, to run with the sows and breed indiscriminately. Mature boars may be bred to a maximum of seventy-five sows per year. Boars in a thin, rundown condition are likely to sire small, weak litters.

Removing Tusks

All boars should have their tusks removed as they develop, otherwise they are dangerous to man and beast. When more than one boar is kept, they may be allowed to run together between breeding seasons if the tusks have been removed.

If it becomes necessary to cut the tusks off during the summer months, a cool day should be selected.

In performing this operation, a noose of stout rope is passed around the upper jaw and made fast to a post or railing of the pen. The tusks, usually quite exposed, may be removed readily with a pair of bolt cutters or by the use of a crowbar and cold chisel. The first method is preferable, but if bolt cutters cannot be procured, the sharp edge of a crowbar may be placed against the base of the tusk and held firmly by one operator, while the other strikes with a cold chisel and hammer directly opposite the edge of the crowbar.

Feet Trimming

A boar's feet should be trimmed occasionally to prevent lameness and broken toenails. Applications of a mixture of pine-tar and neat's foot oil will help to keep the feet healthy and prevent lameness. Trimming may be accomplished while the boar is lying down. If he is approached quietly and with patience, the task can be finished over a period of days.

Age to Breed Gilts

Gilts intended for breeding purposes should not be managed in the same manner as market hogs. The objective should be to stimulate their growth and development without having them become too fat. A thrifty condition is all that is necessary. In the case of any breeding pig, exercise is a very important part of management, in that it tends to develop muscle, feet, and legs. When gilts are managed in this manner they should be ready for breeding at 8 months, and if bred at that time will farrow their first litters upon reaching one year of age.

Time to Breed Sows

Sows usually come in heat three to five days after weaning a litter. The ordinary duration of the heat period is longer for mature sows than for gilts. Experimental work and observation indicates that large litters result from mating late, rather than early, in the heat period; there is also greater likelihood of the sow conceiving at this time. Mating on two successive days may bring about larger litters.

Occasionally sows experience a heat period three to five days after farrowing, at which time they will mate, but seldom conceive. Breeding at this time is neither desirable nor reliable, so is not recommended.

Gestation Table

(Based on 114-day period)

The gestation table below is a convenient guide for basic breeding and farrowing dates:

Date Bred	Due to Farrow	Date Bred	Due to Farrow
Jan. 1	Apr. 24	July 1	Oct. 23
Jan. 10	May 4	July 10	Nov. 1
Jan. 20	May 14	July 20	Nov. 11
Feb. 1	May 26	Aug. 1	Nov. 23
Feb. 10	June 4	Aug. 10	Dec. 2
Feb. 20	June 14	Aug. 20	Dec. 12

Mar. 1	June 23	Sept. 1	Dec. 24
Mar. 10	July 2	Sept. 10	Jan. 2
Mar. 20	July 12	Sept. 20	Jan. 12
Apr. 1	July 24	Oct. 1	Jan. 23
Apr. 10	Aug. 2	Oct. 10	Feb. 1
Apr. 20	Aug. 12	Oct. 20	Feb. 11
May 1	Aug. 23	Nov. 1	Feb. 23
May 10	Sept. 1	Nov. 10	Mar. 4
May 20	Sept. 11	Nov. 20	Mar. 14
June 1	Sept. 23	Dec. 1	Mar. 25
June 10	Oct. 2	Dec. 10	Apr. 3
June 20	Oct. 12	Dec. 20	Apr. 13

Care of the Pregnant Sow

In order to lay the foundation for large litters of strong healthy pigs, sows should be in good condition at the time of being bred. Hence, sows that are thin and run down at the time their litters are weaned should not be re-bred until they have started to gain back some of the weight lost during the nursing period.

Whenever possible, sows which farrow in the spring should have the run of good pasture throughout the summer months. If provided with plenty of green grass, water and shade, mature sows are not likely to need much supplementary feeding, unless they were quite thin when their litters were weaned. However, young growing sows should have some feed in addition to the grass in order to ensure proper development.

During the winter months, dry sows should have access to a yard, and green legume-hay should be accessible to them at all times. If the hay is placed in racks in the yard it will serve the dual function of providing a portion of the ration and of inducing the sows to take exercise. With few exceptions, sows will not maintain themselves in proper condition on hay alone; hence extra feed should be provided in accordance with the recommendations contained in the feeding section of this bulletin.

With respect to shelter the main requirements are, — a dry bed, freedom from draughts, and avoidance of overcrowding. Sows have been sheltered satisfactorily on Ontario farms in straw stacks, and in shelters made by blowing straw over a pole framework. The practice of close housing in small pens is not recommended.

Frequently, a sow's feet do not grow or wear off evenly. Hence it is advisable to periodically trim off the long toes and level the sole of the foot. When this practice is carried out regularly the sow should be able to get up and lie down with greater ease. If done previous to farrowing, it could result in lower mortality of little pigs during the nursing period.

Attention at Farrowing Time

The pregnant sow should be placed in a farrowing pen a week or ten days before her pigs are due, so that she will become accustomed to her new environment. If complications are to be avoided the pen must be thoroughly cleansed in advance. Furthermore, the sow's udder should be carefully washed to remove worm eggs before she is permitted to enter the clean pen.

A farrowing pen should not be less than eight by ten feet. A guard rail around the pen will prevent the sow from lying on or squeezing her pigs. This guard rail should be about ten inches up from the floor and eight inches out from the wall so that the little pigs can slip under it when the sow lies down. A hover heated by electricity, such as is described under the "Building and Equipment" section, will attract the pigs away from the sow, thereby helping to reduce the number lost by crushing.

There are special farrowing crates which provide space for the sow to lie down. On each side of this space are boxes or small areas for the little pigs. The litter can sleep in these side spaces or move into them when the sow lies down to nurse her young.

When the sow's udder gets so full that milk can be squeezed from her teats, when she begins carrying bedding and fixing her "nest", — then the pigs should arrive within twenty-four hours. A good hog producer will be on hand when the pigs start arriving. He will forego some sleep while waiting for the pigs. He can make up this sleep next day, but he cannot bring to life the pigs that die from neglect before daylight. He has fed the sow for four months to get the pigs, so should not take a chance of losing them for the sake of a few hours' sleep.

Occasionally a young pig will be born with the foetal membranes covering its nose. Quick action in removing such obstructions will save the pig.

A sow that has been handled quietly, and fed a well-balanced ration will seldom eat her pigs. The afterbirth and any dead pigs should be removed from the pen immediately after farrowing lest cannibalism be stimulated by the taste of flesh or blood. Unnecessary excitement and lack of confidence in the attendant are often responsible for a sow eating her pigs. However, sows that become chronic pig eaters should be marketed with the least possible delay.

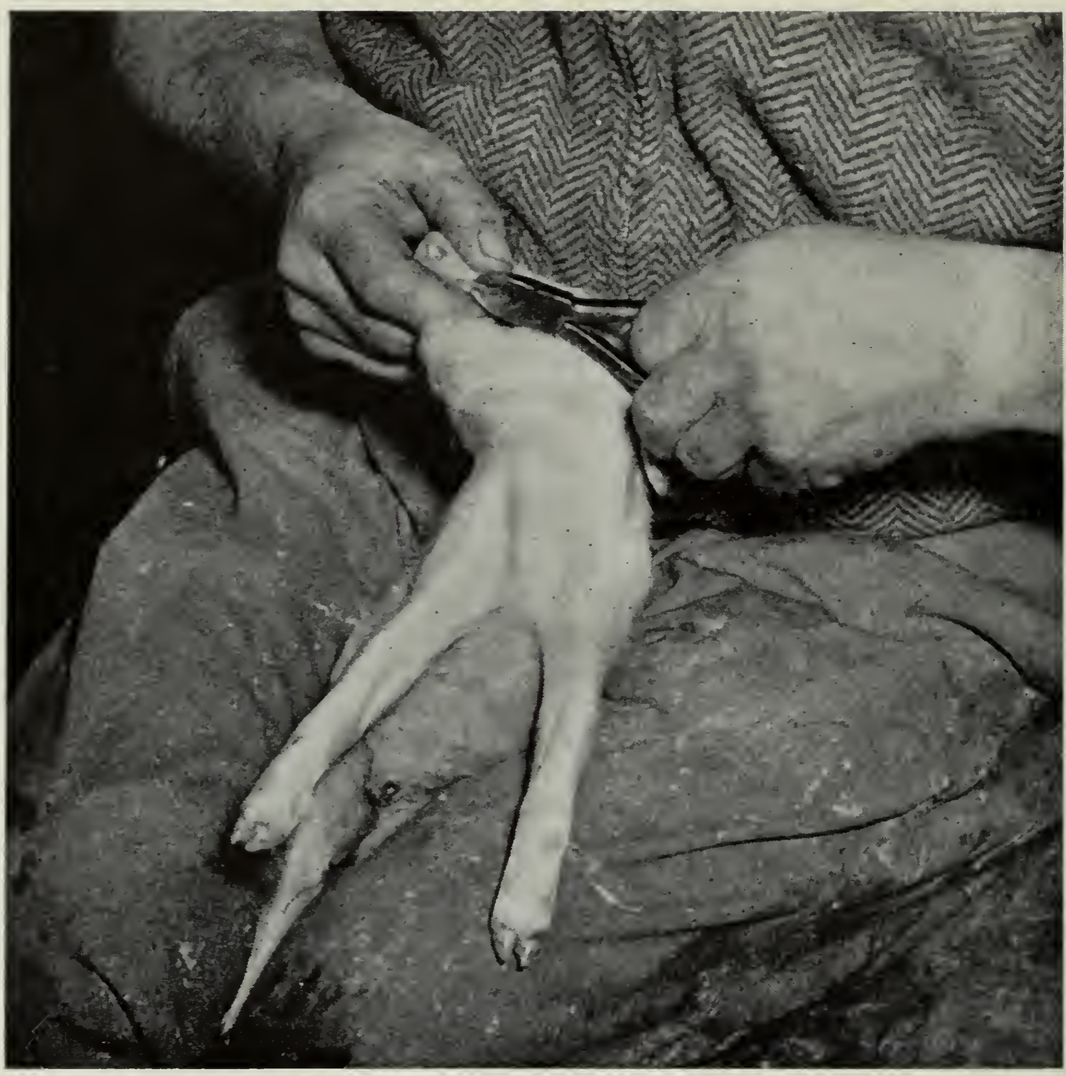
If the litter is large, a newly born pig which is a real runt, or very weak should be killed. It's the humane thing to do since it will probably die anyway.

Thousands of little pigs die from neglect before they are two days old. The "cold spring", or "stormy weather", or other factors are usually blamed for losses that occur as a result of the operator's carelessness or neglect.

When pigs are born in cold weather, it is wise to use a hover. If this equipment is not available, it is a good plan to put the newly born pigs in a basket or box, cover them up immediately, and leave them covered until they are dry. If the weather is very cold, a hot brick, or hot water bottle can be placed in the basket. These heating devices should be wrapped with a cloth to protect the pigs from burns. Chilled pigs may develop scours and pneumonia.

When the pigs are dry, they should be returned to their mother and allowed to fill up on milk. However, in real cold weather mortality can be reduced by keeping the pigs in a box located in a warm place, and removing them for nursing every hour or two until they are strong enough to take care of themselves.

A gentle sow will not object to having her little pigs handled. If a sow is cross, it's usually because an impatient or cross man has been trying to manage her. A little time spent in training a young sow to be handled may prove to be worth many dollars.



Removing the needle teeth

Removing Needle Teeth

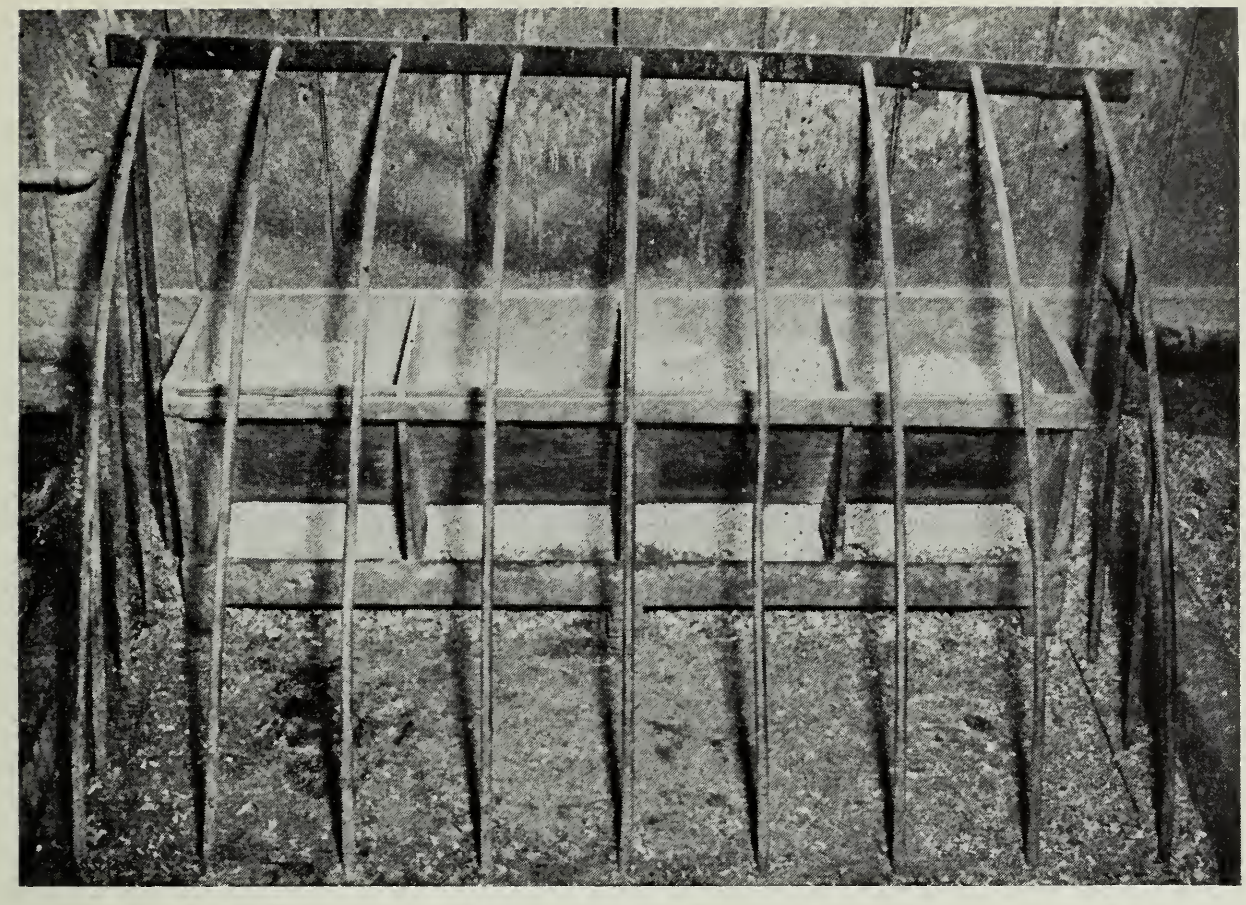
The tusks or needle teeth should be clipped as soon as the pigs are born. Don't crush the tusks or injure the gums; just clip off the tooth above the gum with small nippers. This prevents the pigs from cutting or scratching the mother's udder and scoring each other. The cuts and scratches around the pigs' mouths caused by the sharp needle teeth, can be places for infection to develop.

Supplementary Feeding during the Nursing Period

A creep should be built when the pigs are about ten days old so that they can eat by themselves. Many hog producers put a self-feeder inside the creep in order that the pigs may eat all they want. There is no better way of growing young pigs than to give them all they will eat of the right kind of feed. There is little danger of overfeeding a pig over ten days of age, provided it has sunlight and exercise in the summer, or exercise and living quarters which are maintained at a proper temperature and free from dampness in winter.

Castration

Boar pigs should be castrated at or before reaching one month of age. The following precautions should be taken:— have the pen clean; disinfect hands and tools; keep the pigs out of filth that may infect them. Cleanliness,



Creep for young pigs

a sharp knife, a fairly deep incision going well down on the scrotum to permit drainage, and a disinfectant in the wound, are the main requisites.

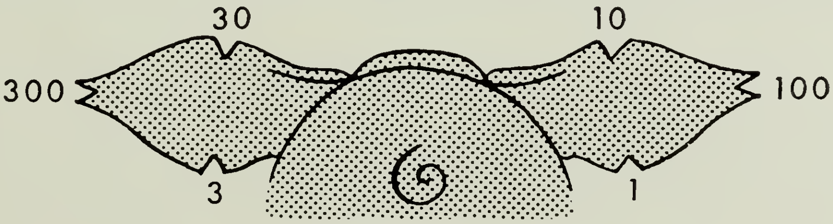
Weaning

A good way to wean pigs is to take the mother away from her young — not the pigs away from the mother. Pigs left in the pen in which they are accustomed to staying are not likely to become homesick or try to break out.

Some hog producers wean pigs gradually; others take the sow away and never let her see her pigs again. Regardless of the method adopted the udder of the sow should be watched closely in order to determine whether or not the milk secretion has stopped. If she is obviously suffering from udder distention, it becomes necessary and wise to allow the pigs to milk her out once. However, if this can be avoided, it is desirable. Reducing the amount of feed for a few days before weaning will hasten the drying off process.

Ear Notching for Identification

Ear Notching for Identification is a simple method of identifying pigs in a commercial herd where tattooing or tagging are not required. It enables producers to keep accurate records of their stock. A V-shaped notch is cut at the edge of the ear with an ear notcher. A simple and satisfactory system is shown below.



Notches, each denoting ten, are placed in the top of the right ear, notches denoting one in the bottom of the right ear, and notches denoting 100 in the end of the right ear. Notches are made in the left ear denoting 30 on the top, 3 underneath, and 300 on the end. Various combinations of notches, representing numbers, may be used to identify all of the pigs in the herd.

Importance of Sanitation

No animal enjoys or responds to clean living quarters more than a pig. Pig troubles, such as worms, sore mouth, bull nose, scours, and other diseases, can be carried over from year to year in filth in and around pens, houses, and yards. "An ounce of prevention is worth a pound of cure". Clean, then disinfect thoroughly according to directions on the disinfectant container should become the standard practice of every hog producer. A lye solution made from one tin of lye added to thirty gallons of water is an excellent disinfectant and destroyer of parasite eggs. It should be applied with a broom or brush. Gloves or mitts should be worn by the operator when applying this solution, and he should stand well back from the container when the lye is being dumped into the water. A coat of whitewash applied after disinfecting, will help to brighten up the pen.

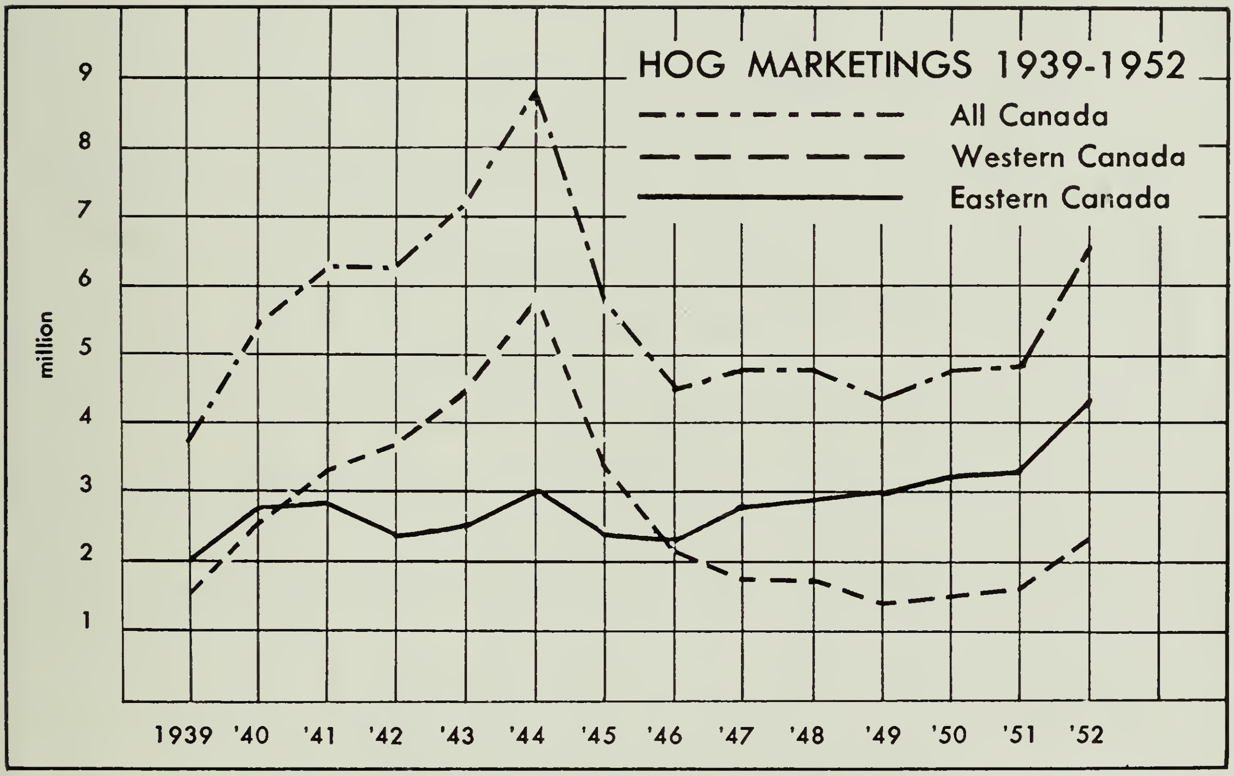
Records

Hog raising is a business. Today, every business demands a system of bookkeeping, if for no other reason than to determine whether or not the year's operations show a profit or loss. An equally important consideration is that a live stock breeder cannot possibly make an intelligent selection of breeding stock without breeding records, and he certainly can use records advantageously in selling breeding stock. It is therefore recommended that a system of bookkeeping be set up for the purpose of recording production in all of its aspects: breeding dates, farrowing dates, numbers farrowed, numbers weaned, weights at weaning age, feed efficiency, market grade, and progeny sold.

Yearly marketing trends

According to a recent census, hogs are being produced on almost two thirds of the farms of Canada. Ninety per cent of the farmers raising hogs have less than 30, which would indicate that they are maintaining from two to four brood sows.

The year-to-year changes in the number of hogs marketed is the net result of almost half a million farmers' decisions with respect to hog production. These decisions change from time to time, a fact well illustrated in the following graph, which shows the number of hogs marketed in Eastern Canada, Western Canada, and the Dominion of Canada during the years 1939 to 1952 inclusive:



This graph reveals that:

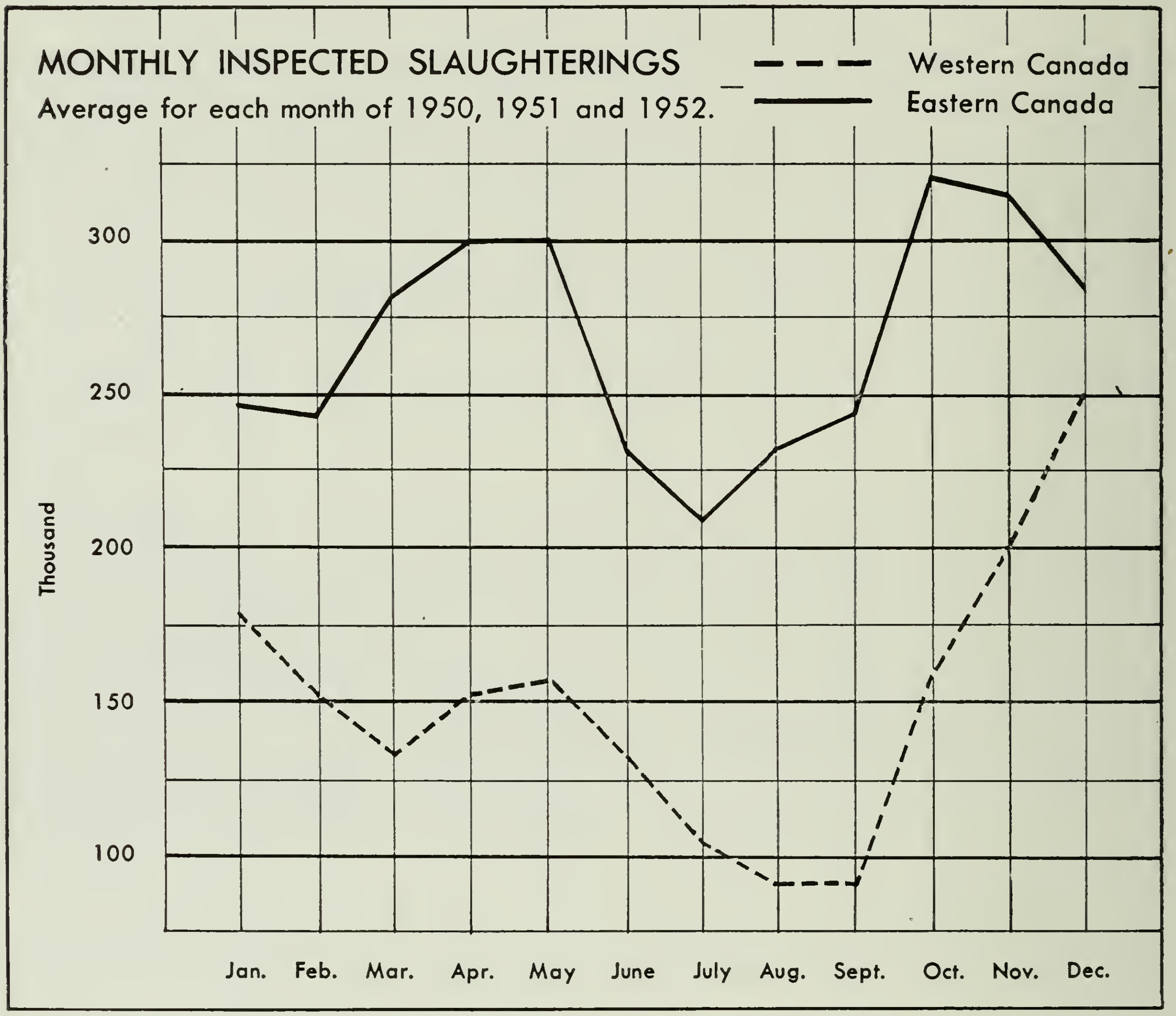
(a) Farmers increased their hog production in response to wartime demands during the years 1939 to 1944 inclusive, but reduced production at a rapid rate when it became evident that the end of hostilities was not far off.

(b) Hog marketings remained fairly constant between 1946 and 1951, but decidedly more sows were bred in the latter year, which is shown by the fact that the high marketings of 1952 created a record for any peace-time year.

(c) Western Canada produced most of Canada's hogs during the period 1941 to 1945 inclusive, but Eastern Canada regained top position in 1946 and held it in each succeeding year.

Monthly trends in hog marketings

In Eastern Canada, it is common practice for each brood sow to produce two litters per year. In the West, this custom is considered impractical on many farms on account of inadequate housing. Where such conditions prevail, farmers select young gilts in the fall and have them bred in December or January for spring farrowing. As a result, monthly marketings are thrown out of balance—surpluses being created during certain months, and scarcities occurring in others. The following graph reveals the monthly average number of hogs slaughtered at inspected plants in Eastern and Western Canada for the years 1950, 1951, and 1952 combined:



It should be noted that:

(a) There are two periods of high marketings in Eastern Canada, with the fall peak being slightly higher than the spring peak.

(b) An extreme peak in marketings occurs in Western Canada in the late fall, and usually continues into the early months of the following year.

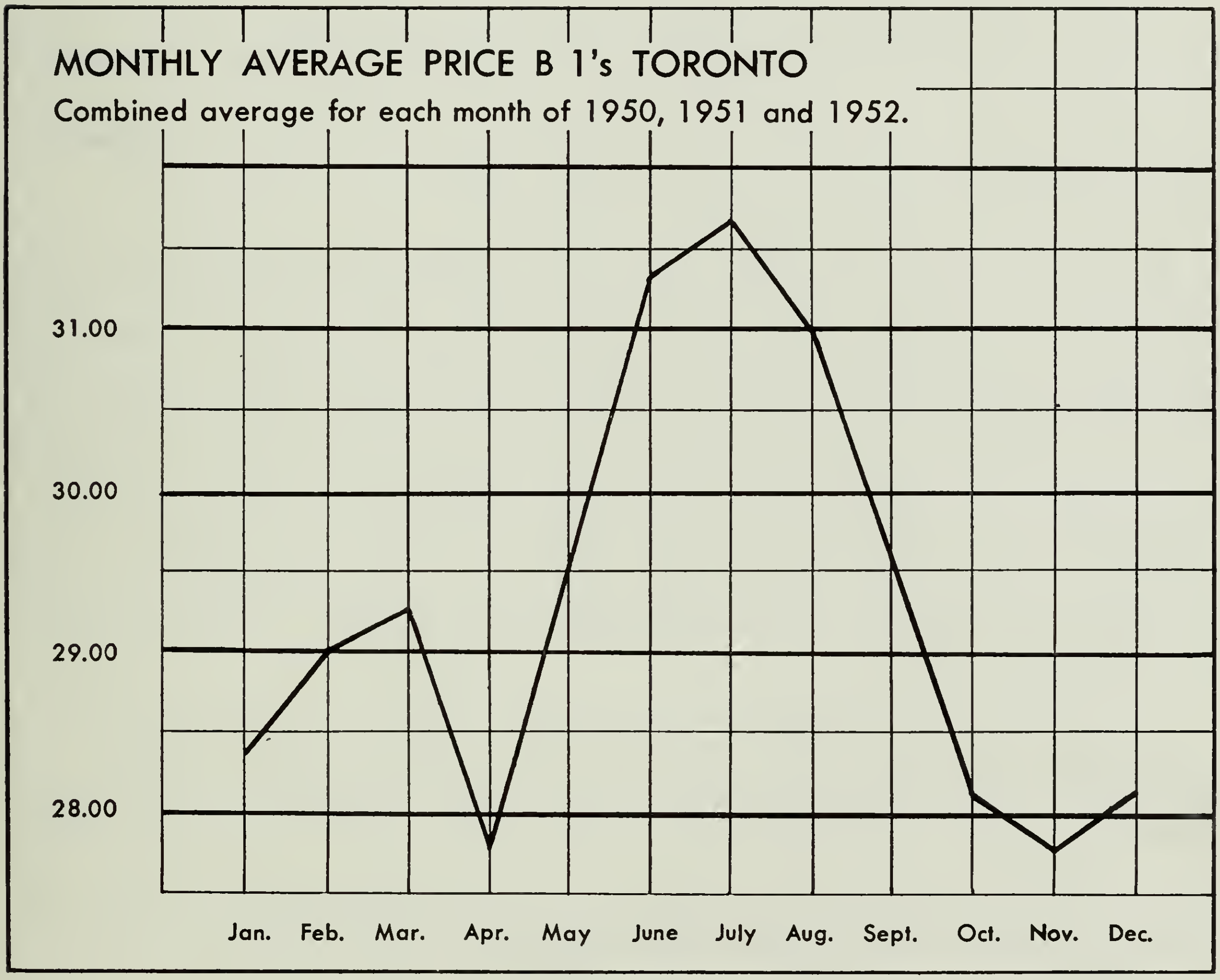
(c) In Eastern Canada, marketings decline to their lowest point in July; in the West, the low point is not reached until September.

(d) Total marketings for July, August, and September are below domestic requirements, while large surpluses are frequently produced in October, November, and December.

Trend in hog prices

Hog prices fluctuate from year to year, month to month, and sometimes from week to week, in accordance with supply and demand. When pork products are scarce, due to low marketings and restricted imports, the price of hogs is determined by the most eager buyers. Since the greatest consuming centres are located in the East, the keenest demand originates in that section of the country. Hence, prices are usually established by traders in Montreal and Toronto. Prices in other Eastern markets bear a fair relationship to those prevailing on the two larger markets, and are frequently the Montreal or Toronto price minus the freight.

When hogs are marketed in numbers exceeding domestic requirements, prices are based on returns received for the surplus which is exported. An exception to this general rule occurs when floor-price policies are in operation. In view of the fact that periods of both short supply and surpluses usually occur during each year, prices follow an erratic course, such as is indicated by the following graph, which shows the monthly average prices for the years 1950, 1951, and 1952 combined:



When monthly prices are averaged by combining several years, the results may be misleading. Actually, in the three years under consideration, the range in prices was from a low of $25.60 for B1's during most months of 1952, when hogs sold at the floor, to a high of $38.36 for the month of July, 1951, the highest monthly average price on record.

Factors influencing hog production

As a general rule, from ten to thirteen months elapse between the time a sow is bred and the date on which her resultant litter is marketed. Consequently, any trends in breeding are likely to be reflected in the form of increased or decreased marketings in the following year. A number of factors influence farmers in making their decisions with respect to breeding, but the following three appear more significant than all others:

(a) **Price.** For some unaccountable reason, a great many farmers seem to believe that the price being paid for hogs at the time a sow is bred will persist throughout the following twelve months. As a consequence, high prices have the effect of encouraging farmers to breed more sows. Twelve months later, they realize that their high hopes were merely wishful thinking. With hog marketings substantially higher and no appreciable increase in demand, prices are scaled down to a level that will either tempt consumers to eat more pork or attract persons with proper facilities to purchase the product and place it in cold storage, in anticipation of future demand. The high prices of 1951 undoubtedly contributed to the record marketings of 1952.

(b) **Feed Supplies.** During years of high grain production, Western farmers are frequently limited in the amount of grain that they can deliver to elevators. Upon realizing that new markets may not be available for at least twelve months, a great many resort to hog production as a means of converting their unsaleable grain into cash. The majority who pursue this course get out of hogs when marketing restrictions on grain are lifted.

In Eastern Canada, more and more farmers are producing hogs with purchased feed. However, there are still a great many who adjust the size of their herds to conform with the amount of grain produced. When crop prospects are favourable and hog prices reasonably satisfactory, an extra sow may be bred, but when the crop outlook is less promising, one or more sows may be shipped to market. Crop conditions are seldom the same in all sections of Ontario, hence farmers in one area may be reducing the size of their swine herds while those in another area are adding more sows. As a consequence, home-produced feed does not exert much influence on the total number of hogs produced within this province, except in years of abnormal crops. However it may be an important factor in determining production in certain areas of the province in any year.

(c) **Need for Additional Farm Income.** A high percentage of costs of production in agriculture are made up of fixed charges for land, labour, and capital. When farm incomes are low, there is a tendency for farmers to work harder and longer hours in an effort to increase their cash returns. In the 1930's, hogs were the favourite method of supplementing declining incomes because the initial cost of breeding stock was relatively low, and high gross returns on invested capital could be expected within twelve months.

The hog-feed ratio

The term "hog-feed ratio" refers to the relationship between the price of hogs and the cost of mixed feed at Toronto. It is determined by use of the following formula:

$$\frac{\text{Price of 100 lbs. of B1 live hog plus federal premium.}}{\text{Cost of 100 lbs. of mixed feed}}$$

The price of 100 lbs. of B1 live hog is equal to 75% of the amount received for 100 lbs. of B1 carcass, while the present federal premium is $1.00 per hog, or 50¢ per cwt.

When calculations are made according to this formula, the answer represents the number of hundredweights of mixed feed that a farmer must sell in order to secure the same gross returns as are obtainable from the sale of 100 pounds of B1 live hog.

The long-term average, namely the average ratio prevailing between 1914 and 1941, was 6.7. Hence, on the average, one hundred pounds of B1 live hog had a value equal to 670 pounds of mixed feed. Since the latter quantity of feed is considerably more than is required to produce 100 pounds of live hog, the margin over feed costs was quite favourable to hog production during those years.

The information obtained by applying the hog-feed ratio is very useful in estimating future trends in production. As a general rule, when the ratio is above the long-term average, more sows are bred and marketings register an increase twelve months later, but when the ratio is below 6.7, the trend is in the other direction.

Cold Storage

Cold storage plays an important role in swine marketing. During periods of heavy supplies, carcasses or cuts not required for immediate consumption may be removed from the market and placed in freezers. Unfortunately, pork cannot be held in a frozen state for more than three or four months without suffering some deterioration. As a consequence, products placed in storage during the fall months when marketings are at their peak cannot be held over until the following summer. However, the problem of making supplies available during months of low marketings is partially solved by rotating storage stocks.

The use of storage facilities has a levelling influence on hog prices. Persons willing to take the risk purchase products when supplies are plentiful, thereby removing some of the surplus from the market. Their action tends to stabilize the price at a time when it might otherwise continue its downward course. These storage stocks can be offered when current supplies are short, thus preventing prices from skyrocketing.

Although storage facilities are useful in levelling out supplies and prices, the problem associated with price fluctuations will never be solved until hogs are marketed in more uniform numbers throughout each month of the year.

Grade standards

Grade standards for hog carcasses are described in regulations made under the Live Stock Products Act, 1950. When the grades were established, weight, length, and finish were given primary consideration. The following table records the grades of hog carcasses and the specifications of each.

Grading hog carcasses

Under the present system, carcasses are graded at packing plants by officers of the Marketing Service, Canada Department of Agriculture. Each carcass is weighed after the hair and entrails have been removed and splitting has been completed. A special ticket showing the hot weight is attached before the carcass is moved along the rail to a position directly in front of the grader.

Grade	Weight Range	Minimum Length	Maximum Shld. Fat	Maximum Loin Fat
A	140-170 lb.	29″	2″	1½″
B1	135-175 lb.	28″ to 29″	2 to 2¾″	1½ to 2″ according to wt.
B2	125-134 lb.	27″	2″	1½″
B3	176-185 lb.	30″	2¾″	2¼″
C	120-185 lb.	none	2¼ to 3¼″	1¾ to 2½″ according to wt.
			May be overfat, lacking in length, type, or balance.	
D	120-185 lb.	none	May be very fat, short, or lacking in balance. Also includes unfinished, rough, soft, or oily carcasses of any weight.	
Lights	119 lb. & under	Shall have reasonable finish and quality.		
Heavies	186-195 lb.			
Extra Heavies	196 lb. & over			

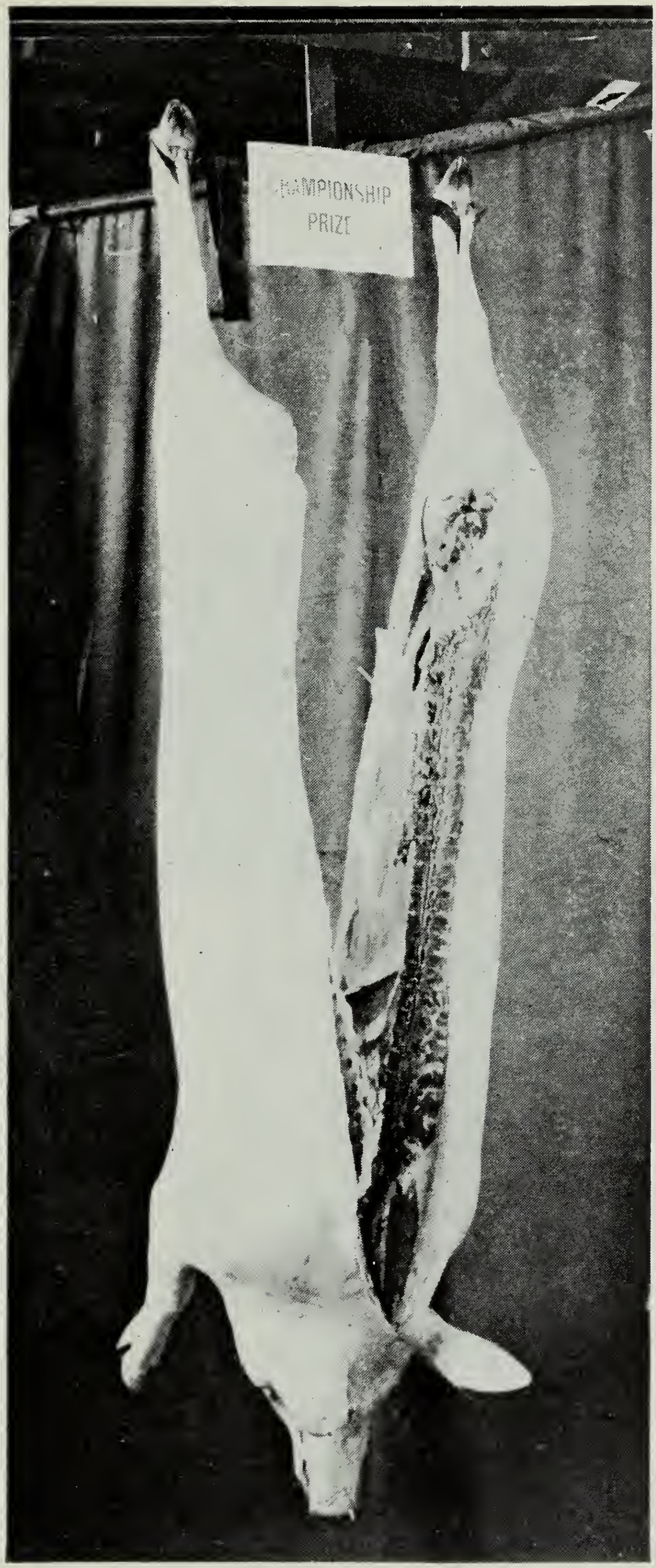
Before deciding upon the grade, he examines the carcass for type and finish, and the ticket for weight.

In order that each hog's identity may be preserved throughout the marketing operations, every shipper is required to tattoo each producer's lot with a distinctive mark before it is allowed to mingle with any other hogs. These marks, if properly applied, will be quite legible after slaughter. The shipper must also furnish the grader with a manifest showing the identity of each producer's hogs. When grading has been completed, the grader records the grade and weight of each carcass in each producer's lot on a certificate. All settlements, whether by a packer to a shipper or producer, or by a shipper to a producer, must be on the basis of the official grade shown on the certificate.

Price differentials and government premiums

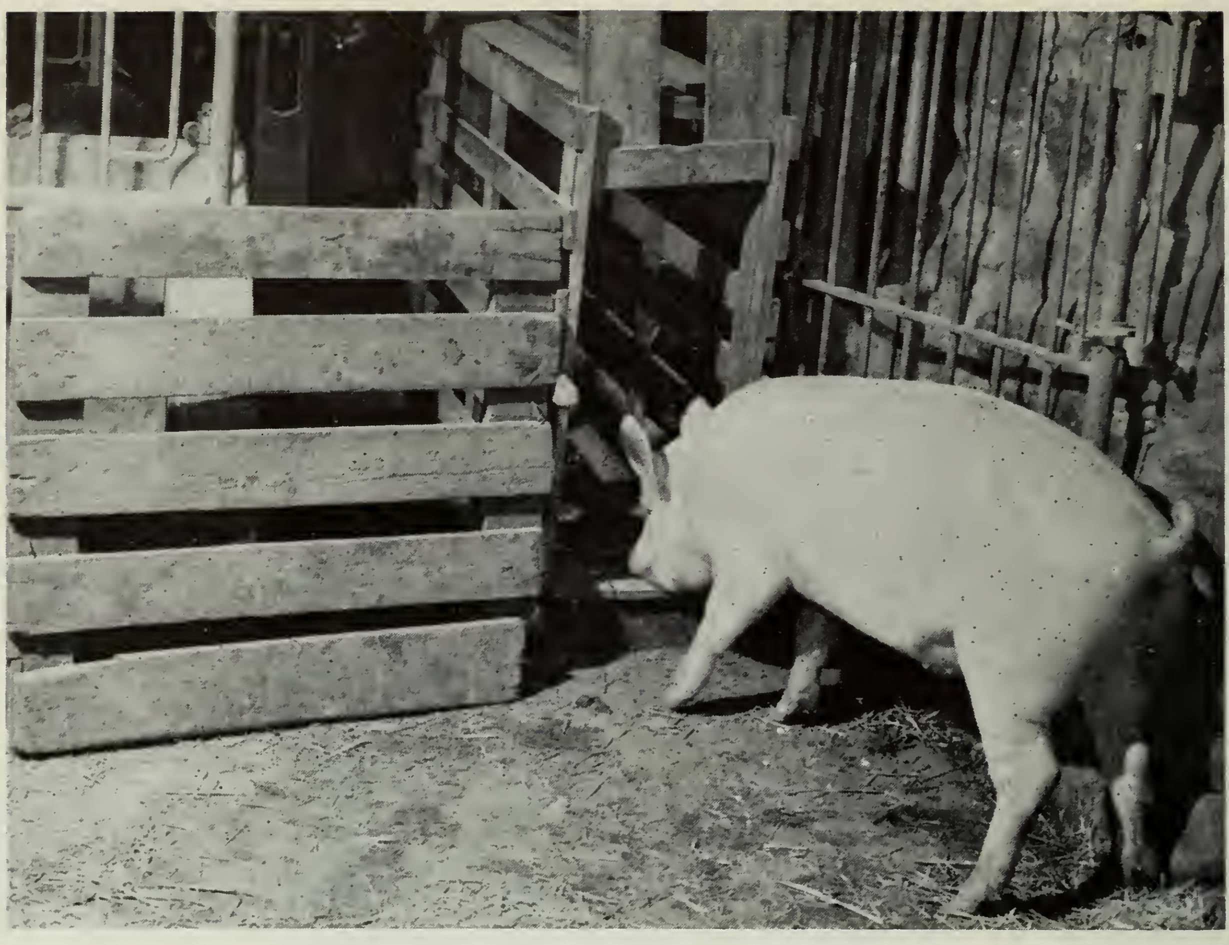
In Ontario, all hog-price quotations refer to the price being paid for Grade A carcasses. Standard deductions are made at all packing plants for carcasses below the top grade. The deductions in effect at the present time are as follows:

A's	Basic Price
B1's	$1.00 per cwt.
B2's	$1.25 per cwt.
B3's	$1.60 per cwt.
C's	$3.00 per cwt.
Lights	$3.50 per cwt.
Heavies	$3.25 per cwt.
Extra Heavies	– According to market value.
D's	– According to market value.



A championship carcass showing length, balance, flatness of side and uniformity of back fat.

During World War II, the Canadian Government instituted a policy of paying premiums for quality hogs. These premiums are $2.00 for each A, and $1.00 for each B1 carcass. Payment is made by a warrant attached to the combination grading certificate settlement form, and such warrants are negotiable at any chartered bank.



Don't guess the weight of your hogs

Marketing hogs at proper weights

A great many hogs of proper type and finish fail to qualify for the A grade because the carcasses do not conform to the weight specifications of that grade. Consequently, a good job of breeding and feeding can become a wasted effort through neglect or failure to recognize the importance of marketing hogs

Live Wt.	Dressing Percentage										
of Hogs	70%	71%	72%	73%	74%	75%	76%	77%	78%	79%	80%
170	119	121	122	124	126	127	129	131	133	134	136
180	126	128	129	131	133	135	137	139	140	142	144
190	133	135	137	139	141	142	144	146	148	160	152
200	140	142	144	146	148	150	152	154	156	158	160
210	147	149	151	153	155	157	160	162	164	166	168
220	154	156	158	161	163	165	167	169	172	174	176
230	161	163	166	168	170	172	175	177	179	182	184
240	168	170	173	175	177	180	182	185	187	190	192
250	175	177	180	182	185	187	190	192	195	197	200

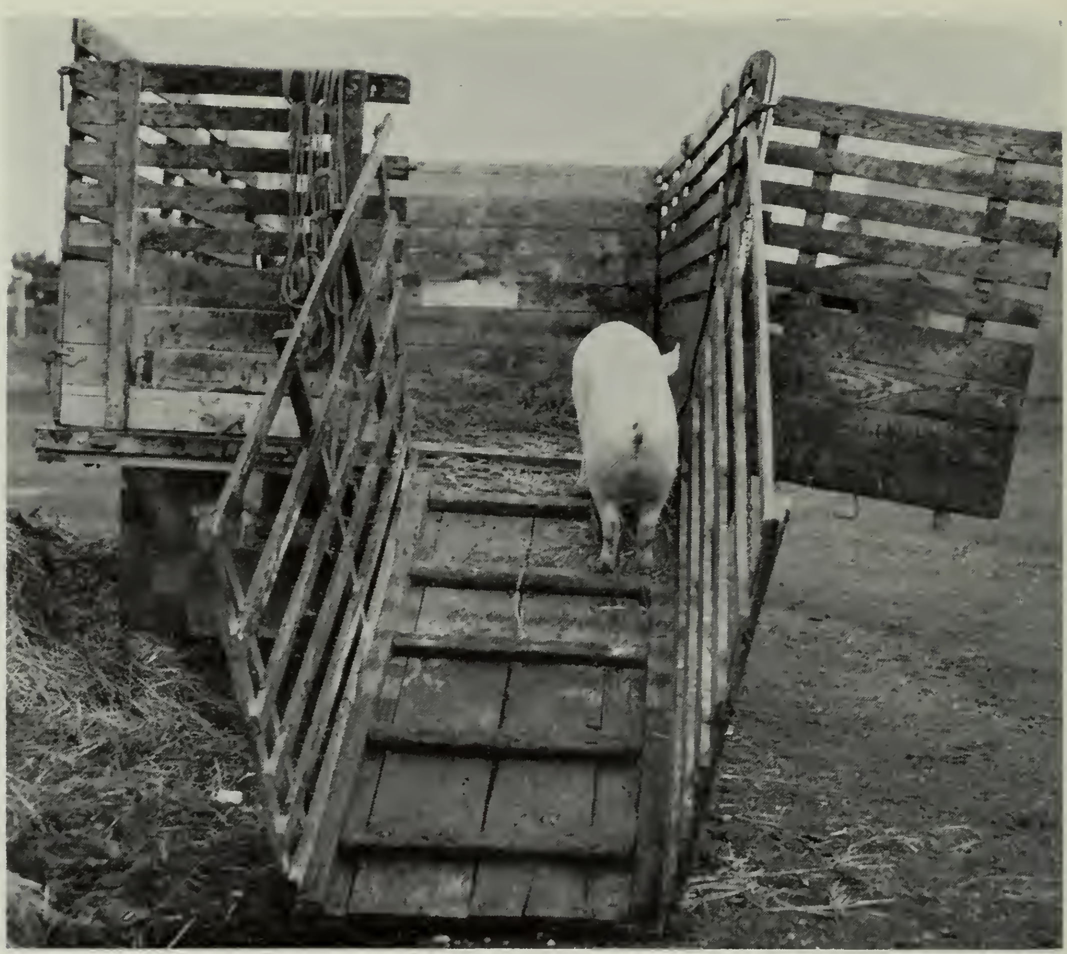
at the proper weight. The chart on page 62 indicates the weight of hog carcasses obtained from hogs weighing 170 to 250 pounds when the dressing percentage ranges from 70% to 80%.

The figures in the darkened section of the chart are within the range for Grade A carcasses, which is 140 to 170 pounds. It is possible for a hog weighing 180 pounds to yield a carcass within that range provided the dressing percentage is 78 or more, a situation which seldom occurs except when hogs have been starved out before being weighed. It is also possible for a 240-pound hog to yield a carcass weighing 170 pounds or less, but only when the dressing percentage is 71 or lower, which is a rare occurrence. Hogs weighing 170 pounds or 250 pounds cannot be expected to produce carcasses of the preferred weights. On the other hand, hogs weighing 200 to 210 pounds will invariably yield carcasses of 140 to 170 pounds. Producers can increase the number of Grade A carcasses by marketing hogs at these weights.

Bruising

Bruising causes losses amounting to millions of dollars annually. Hogs may be bruised at any period of their lives, but the bruises which cause the most serious losses are usually inflicted during marketing operations. The damage can be done while the hog is being loaded at the farm, or in transit to the stock yards or packing plant, or after arrival at these points. A jab in the ribs with a sharp object or a whack across the back with a cane will

The wrong way



The right way

produce a damaged portion below the point of contact. This portion must be removed before the carcass can be offered for sale. Although losses from bruising do not appear as a direct charge on producers' settlement statements, the extent of such losses is undoubtedly taken into consideration when the price is established.

Losses from bruising can be greatly reduced if every person connected with the marketing of hogs will exercise a little more care and restraint. Since a lot of damage is done during loading operations, every farmer should have a good loading chute, which could be used in the event that the trucker does not carry one. Overcrowding in trucks, stock cars, or yards must be avoided. Furthermore, hogs should not be mixed with cattle while in transit. Canes frequently become dangerous weapons when used by persons engaged in handling hogs. If some instrument must be used for directing a hog, a slapper is preferable. It is a canvas strap attached to a suitable handle, which, when brought into contact with the pig's body, creates a great deal of noise, but seldom causes any pain or injury.

In the final analysis, it should be borne in mind that hogs can be stubborn and obstinate, but rough treatment will not correct these characteristics. A little patience, tempered with gentleness, usually produces a favourable response.

DISEASES OF SWINE

Hog Cholera

This is an acute infectious disease of swine caused by a virus. It is highly contagious and spreads rapidly through a herd causing heavy death loss.

Sometimes deaths may occur in a herd without previous warning. More generally affected swine are noticed sick for several days showing some, although not necessarily all, of the following symptoms: high fever, loss of appetite, drooping ears, reluctance to move, staggering gait, gummy eyelids, vomiting, purplish patches on the skin especially of the abdomen. The death rate is extremely high.

In Canada outbreaks are handled by a slaughter policy with indemnity paid to owners. This policy has been very effective in stamping out the occasional outbreaks which occur. Since these outbreaks can, in most cases, be traced to the feeding of uncooked pork scraps originating in countries where the disease is prevalent, all garbage should be cooked thoroughly before being fed to swine.

When the disease is suspected, notify your local veterinarian or the nearest office of the Health of Animals Branch, Canada Department of Agriculture.

Swine Enteritis

Enteritis is a broad term meaning inflammation of the intestine. When enteritis occurs in swine, infectious agents almost invariably contribute to it. Nevertheless, it is generally believed that deficiency of one or more food elements exists in the majority of swine herds where enteritis occurs in Ontario. Under laboratory conditions enteritis is known to be a symptom of a number of vitamin deficiencies. However, on the farm a deficiency of a single vitamin is seldom encountered. On the other hand, multiple deficiencies, particularly of the B complex group, are not uncommon where rations are limited to the common grains without supplementation. In addition a number of infectious agents are capable of causing enteritis either alone or in association with a nutritional deficiency.

In view of the variety of causes of this disease, it is not surprising that symptoms vary considerably in different outbreaks. In most instances, however, the pigs are noticed to be unthrifty and to have a rough scurfy skin before other symptoms are shown. Diarrhoea is an early symptom and is persistent. When the discharge is bloody, the disease is usually severe and infectious. As the disease progresses, the pigs become thin, weak, and gaunt.

The death rate is extremely variable but the loss in weight is always considerable. Frequently, recovered pigs are permanently stunted.

Whether an individual outbreak is primarily nutritional or infectious in origin, the following points are suggested for the control of the disease.

(1) Separate sick and healthy pigs. If possible, put both groups in fresh lots or pens.

(2) Contaminated quarters should be cleaned and disinfected.

(3) Have the pigs treated promptly by a veterinarian. Most veterinarians use laxatives and antibiotic or arsenical preparations in the feed in treating

this condition. Feeds heavily fortified with B vitamins or injections of these vitamins assist in bringing the pig back to normal.

In preventing the disease, two points appear to be most important:

(1) Feed the weanling pig so that no deficiency, particularly of the B vitamins, can occur.

(2) When purchasing pigs, purchase only from a source known to be free of the disease. Even then, isolate the newly purchased pigs for ten days before putting them with the rest of the herd.

Infectious Rhinitis

While this disease has undoubtedly existed in various parts of North America for many years, it is only recently that it has assumed major proportions. It must now be ranked as one of the most important swine diseases.

Rhinitis is an infectious disease, the infection generally becoming established during the first few weeks of the pig's life. The exact method of transmission is unknown, but it appears that infected breeding stock and contaminated pens are the principal sources of infection. The death rate is usually low: the main economic loss is through stunting and inefficient use of feed. Frequently, affected hogs require two or three additional months to reach market weight.

The first symptom noted is usually sneezing due to irritation of the lining membranes in the nose. As the disease progresses the internal structures of the nose become more severely affected, often causing distortion. The nose may turn to one side or the other or may appear shortened in relation to the lower jaw. In some cases blood is discharged from the nostrils. Breathing may be difficult and affected pigs seem more susceptible to other respiratory conditions such as pneumonia.

So far, no specific treatment has been discovered for rhinitis and no measurable effect in preventing the condition can be attributed to any biological product.

In preventing the establishment of infection in a clean herd, particular care should be taken in the selection of replacement breeding stock. It is recommended that breeding stock be purchased only from sources known to be free of the disease. It is not enough to select apparently normal animals from an infected herd. Such animals are often carriers of infection. Pigs of unknown origin are poor risks.

When the infection is widespread in a herd the following is suggested:

(1) Separate the infected from the normal pigs and, as soon as possible, remove breeding stock to separate quarters.

(2) Market all hogs as soon as they attain market weight.

(3) Slop feeding is recommended for hogs showing symptoms of rhinitis.

(4) When all pigs are marketed the piggery should be thoroughly cleaned and disinfected. A lye solution (1 pound of lye in 15 gallons of hot water) is satisfactory if applied as a spray or with brushes. After the pens are dry whitewash may be applied.

(5) Leave pens empty for about a month before bringing in new pigs.

(6) There is no completely satisfactory method for identifying infected

animals. In purchasing fresh breeding stock reliance must be placed on close personal observation and the integrity of the breeder.

Pneumonia

Pneumonia is a term which refers to an inflammation of the lungs. It is one of the most common diseases of Ontario swine. The condition occurs in pigs of all ages and at all times of the year, but is most prevalent in young growing pigs during the colder seasons. It is now believed that most swine pneumonias are caused primarily by a virus; however, various bacteria have been isolated from infected pigs and may contribute to the severity of the disease. Malnutrition and inadequate housing may play a part by lowering the pig's resistance to these infectious agents.

Infected pigs may have a dry hacking cough and sneeze frequently at the onset of the disease. Later, respiratory difficulty is indicated by "Thumps" (jerky, forced expiration). Appetite is reduced to some extent depending on the severity of the condition, and the pigs become unthrifty in appearance. If large areas of the lungs are involved young pigs may be severely stunted. Occasionally an acute form occurs which may result in the death of several pigs within a short time after the onset of symptoms.

The swine owner can do much to prevent or minimize the effect of this disease in his herd. Infected pigs remain carriers for some time and, therefore, should not be retained for breeding stock. New gilts to be added to the herd should be kept separate from the rest of the herd until after they have weaned their first litter. The growth of this first litter will be an indication whether the dam is free from infection.

Properly balanced rations and dry warm housing are essential both to prevent outbreaks of pneumonia and to assist in returning infected pigs to health. Certain drugs have proved useful against this condition. A veterinarian should be consulted whenever growing pigs are not gaining well and have a poor appetite. Pneumonia could be the cause of this unthriftiness. Prompt attention may assist in preventing considerable economic loss.

Swine Erysipelas

Swine erysipelas is an infectious disease which causes heavy loss in some Ontario herds. Much is still unknown about the manner in which it spreads. However, there is no doubt about its infectious nature, and it is possible that the germ which causes it can live in the soil. Many species of animals and birds can be infected including lambs, turkeys and occasionally man.

Common symptoms of the acute form are high temperature, loss of appetite, stiffness or weakness in the limbs, and reddish discoloration of the skin. Death loss may be high in this form of the disease.

A milder form is evidenced by slight rise of temperature and the appearance of dark patches on the skin which eventually slough off. These are sometimes diamond shaped giving rise to the term "diamond skin disease". Sometimes the disease takes the form of acute or chronic arthritis with few general symptoms other than stunted growth.

Veterinarians are generally successful in treating the acute form of the disease with antiserum and antibiotics. The chronic forms respond less well. In our present state of knowledge no practical system of prevention can be recommended with complete confidence. However, antiserum affords protection to susceptible animals for a period of two or three weeks which allows time for the isolation of those showing symptoms and the disinfection of infected premises. Since recovered animals may be carriers, their retention as breeding stock is not advised.

Swine Tuberculosis

Swine are susceptible to all three types of tubercle bacilli (bovine, avian and human) although generalized cases seldom occur. In Ontario, most infections are caused by contamination of pastures or feed pens with the droppings of infected poultry. Occasionally, milk or milk products from infected cows may be the source of the disease in swine.

In most instances evidence of the disease is confined to the lymph glands and is discovered only at post mortem. The disease can be detected in the living animal by means of the tuberculin test. When the infection is found, diseased pigs should be eliminated and attention directed to the discovery and elimination of the source of the disease.

Mastitis in Sows

The term mastitis refers to an inflammation of the udder. It is generally caused by infection although other factors such as injury and chilling may play a part. The rear glands are more frequently affected, largely because they are more exposed to injury.

The acute type of mastitis generally occurs soon after farrowing. The affected glands become hot and painful and the milk from them thick and clotted. General symptoms such as fever, loss of appetite, constipation and diminished milk flow may be observed. The glands may become so painful that the sow will not allow the pigs to nurse. Veterinarians use antibiotics and sulfonamide drugs in treating acute mastitis. When the services of a veterinarian are not immediately available a laxative of Epsom salts and the application of alternating hot and cold packs to the affected glands will give some relief.

At times mastitis may take a chronic form. In such cases the affected glands may become very hard or abscesses may form, rupture and discharge pus. Treatment is less successful than in the acute type of the disease. In valuable animals surgery may be worthwhile but in commercial animals marketing is advisable.

Prevention consists essentially in the application of good herd sanitation, forestalling injury by eliminating obstacles which could cause bruising, and the prompt removal of chronic cases. All wounds on the teats and udder should be cleaned immediately and an antiseptic ointment or powder applied.

Agalactia (Lack of Milk)

Agalactia is a condition manifesting itself immediately after farrowing. It is more commonly observed in gilts and second litter sows. The various causes are hormone failure, post parturient fever, mineral deficiencies, excess fatness and lack of exercise during gestation.

The only symptom observed in most cases is a lack or total absence of milk. Occasionally systemic symptoms such as lack of appetite and fever are seen.

Treatment is successful in the majority of cases caused by hormone failure. In complicated cases, however, treatment results merely in a brief and limited improvement and has to be repeated until the cause is determined and corrected.

It should be remembered that starvation for even a day or two will kill a newborn pig, particularly if the pen is cold. While the sow is under treatment, the pigs should be kept warm and given cow's milk fortified with ordinary sugar or glucose. Later the pigs may be reared on prepared milk substitutes. If it is desired to transfer pigs to another sow, the operation may be facilitated by rubbing the sow's nose in a rag soaked in kerosene, then lightly stroking both her own pigs and those which are to be transferred with the same rag.

Paralysis after farrowing

This condition is characterized by a paralysis of the hind limbs shortly after farrowing. The cause in most cases is obscure, but is usually the result of one or more of the following: vitamin and mineral deficiencies, lack of exercise with excessive fatness, injury or constipation.

The paralysis may come on suddenly but usually develops gradually. First the sow shows an unsteady gait and is unable to control the hind-quarters. As the condition progresses, walking becomes more difficult and weakness more pronounced until the sow is unable to stand on the hind legs. When forced to move she drags the hind-quarters.

Since the cause is usually obscure a veterinarian should be consulted. The first step, however, is to make the animal as comfortable as possible. If there is evidence of constipation a dose of Epsom salts (4 to 8 ounces) or raw linseed oil should be given. Provide clean bedding and fresh drinking water. The diet should be light and consist of a slop of bran and milk. If the sow is suckling a large litter, the litter should be weaned and the sow fed a well balanced ration to restore her vitality.

A similar condition may appear late in the lactation period due to fracture of one or both of the hind legs or the vertebrae. Generally such fractures are the result of a mineral deficiency and can be prevented by adequate feeding.

Swine Pox

Swine pox is a contagious disease of swine characterized by the development of skin eruptions. The disease is caused by a virus and is transmitted indirectly by the hog louse. Mainly, young pigs are affected, and in a relatively mild form. First there is a slight fever and partial loss of appetite. After a few days small red swollen areas develop on the belly, thighs and flanks. Later the swellings become pustules and, when these break, small circular scabs are formed.

While marked systemic symptoms are not common, occasionally complications may develop with some death loss. Animals recovering from a natural attack of the disease develop an immunity to subsequent infection.

The disease usually runs its course within a few weeks without any great effect on the pigs. Treatment may not be necessary unless complications develop. To prevent the disease, it is necessary to control the hog louse.

Dermatitis

The term dermatitis means an inflammation of the skin. The condition may be acute or chronic, the latter being the more common in swine. As there are numerous agents which can set up a dermatitis of varying degrees of severity so there are a large variety of clinical pictures. In swine the common causes are malnutrition, poor husbandry, parasitism and skin infections but, in many cases, the cause cannot be determined.

The inflammation may originate in one or several limited spots which gradually enlarge and fuse. On the other hand the inflammatory process may extend over a large area from the outset. Along with the usual symptoms of inflammation, itching may occur. The skin in chronic dermatitis is rough and of a tougher consistency. Its elasticity is lessened causing deep furrows. There may be reddish brown to black discoloration of the skin with crust formation.

Since the symptoms of dermatitis are very similar to those of mange, it is advisable to have your veterinarian exclude the possibility of this disease before treatment is started. If necessary, dietary deficiencies should be corrected and internal parasites eliminated. Local treatment consists of removal of crust after softening with oil or soap solutions, followed by the application of antiseptic oils.

Gut Edema

This condition is so termed because of the well defined post mortem findings seen in the majority of pigs which die. Although the disease has been transmitted experimentally, the cause is unknown. Most cases, however, are encountered in pigs 8 to 14 weeks of age and usually following a change of feed or environment.

The symptoms shown first are loss of appetite and a staggering gait. This is closely followed by the appearance of swelling affecting the eyelids and often extending over the snout. There may be a peculiar squeal suggesting swelling of the larynx. The staggering gradually becomes worse and may result in a general paralysis.

Once symptoms are shown, death occurs so quickly that there may be no time for treatment. It is worthwhile to stop all feeding at once and clean out the feed troughs. Recommended treatment is a light bran slop containing Epsom salts at the rate of about 2 ounces per pig. Preventive measures are uncertain but, since most outbreaks are associated with sudden changes of feed, such changes should be avoided.

Vesicular Exanthema

This is a virus infection very similar to foot and mouth disease but not transmissible to cattle. It is common in the United States where it is generally associated with garbage feeding, but it has not yet been diagnosed in Canada.

Symptoms are similar to those of foot and mouth disease in swine. There are vesicular eruptions upon the snout, the lips, the lining of the mouth and tongue, and around the feet. Lesions also appear on the teats of nursing sows. Ruptured vesicles heal rapidly although serious losses may occur in pigs under 2 weeks of age.

If this disease is suspected do not attempt treatment but notify your local veterinarian or the nearest office of the Health of Animals Branch, Canada Department of Agriculture.

PARASITE CONTROL

Internal Parasites

Parasites specifically infesting swine are described and illustrated in the Ontario Department of Agriculture Bulletin No. 496, "Internal Parasites of Swine", which discusses parasites under the headings of the organs they infest. This bulletin gives much greater detail than is possible here on methods of prevention and control. It includes sections on coccidia, flukes, tapeworms, lungworms, large intestinal roundworms, stomach worms, thorny-headed worms, nodular worms, whipworms, kidney worms and others.

From a public health viewpoint, the most important swine parasites are the microscopic garbage worms. They cause the dreaded and sometimes fatal disease — trichinosis — in persons who eat undercooked, infected pork products. In the past, the presence of these worms has seriously affected hog export trade between countries of the New and Old Worlds. There is little excuse for these parasites to exist in modern piggeries; thorough cooking of garbage and elimination of rats will protect pigs from infection. Pork cooked until the flesh is grey is safe for human consumption. Armed tapeworms also occur in the intestine of man as a result of eating undercooked pork. Pigs become infected with the larval forms of this parasite by having access to land fertilized with, or contaminated by, human excrement.

The most common parasite in swine is the large intestinal roundworm which is responsible for illness and, in many cases, the death of pigs. The hog producer's best insurance against losses from this and other worms is to familiarize himself with this type of parasite, and to practise the McLean County System of Swine Sanitation and its modification, which are described in the bulletin referred to previously.

Treatments for Parasites

If, through various circumstances, pigs fail to make gains and become ill or commence dying, the possibility of parasitism being the cause should be considered. Other disease factors, however, must be eliminated because sick pigs should only be treated for parasites when definite diagnoses of parasitism are made by symptoms shown and by microscopic or post mortem examinations.

Contraindications for Treatments with Worm Remedies

Pigs with high temperatures (over 103° F.), secondary bacterial infections, anemia, or marked weakness are not likely to tolerate any worm medicines. Usually, brood sows should not be wormed immediately before or after farrowing; the best time to treat sows being shortly after they are bred. Very young pigs will not always tolerate worm remedies. Care must be used in the choice of drugs for pigs under four weeks of age. Drugs given to pigs heavily infested with roundworms sometimes cause the worms to collect in masses and fatally obstruct the bowels.

Hygiene, Feeding, and Nursing

When parasites are suspected of being the cause of disease, it is necessary to reduce further intake of eggs, young worms, or protozoans by removing the sources of infestation. Pens must be cleaned thoroughly, or pigs moved to temporary quarters on clean ground, where they are provided shelter, ample dry bedding and adequate rations, including any minerals or vitamins that may have been lacking in their diets. The use of antibiotic feeds may also help prevent or control secondary bacterial infections.

The health of markedly sick pigs may sometimes be improved, prior to treatments, by good nursing, the administration of tonics, and the treatment of symptoms such as those of bronchitis, pneumonia, anemia, diarrhoea, or constipation.

Preparation for Treatment with Worm Remedies

For the administration of some drugs, animals require preparations which consist, in the case of intestinal parasites, of partially emptying the stomach and bowels of food by starvation. This is necessary to prevent undue dilution of drugs used, and to expose the worms to their action. It is not necessary in all cases, and in some is undesirable. The correct procedure to follow is usually indicated in printed directions accompanying worm remedies; these directions should be read carefully and meticulously followed. Dosages of drugs must be varied according to the ages and condition of pigs requiring treatments. It is wise to treat a few animals before administering drugs to whole herds.

Individual Treatments with Worm Remedies, Administrations of Medicines, and Methods of Restraint

Individual treatments ensure correct, safe, and effective doses of medicine being given to all pigs treated; hurdles, catching gates, pig catchers, or snares are required to facilitate treatments of this type.

Worm remedies are usually administered in the form of drenches or capsules given with balling guns, forceps, or stomach tubes. Suitable mouth gags or specula are required. The successful administration of capsules to pigs, and the passing of stomach tubes are dependent upon introducing the objects into the gullets, and upon avoiding the windpipes and pharyngeal recesses. These latter structures are small, blind pouches, and each pig has one immediately above the opening into the gullet. The accidental introduction of capsules into these pouches may do much harm or prove fatal.

Quite large pigs may be suitably restrained by sitting them on their haunches and holding them up by the forelegs, with the backs of their bodies wedged between the restraining person's knees. Small pigs are restrained in a similar manner, but with their hind feet just touching the ground. Boars, sows, and pigs too large to manage by hand must be restrained with special tackle. Most drugs, though not all, are given to them with their food. A taste of grain given to pigs immediately before and after treatment stimulates salivation.

Kindness and careful handling of pigs of all ages makes them more amenable to treatment.

Sodium Fluoride is from 93 to 95% effective against immature and mature large intestinal roundworms and stomach worms (**Ascarops** and **Physocephalus**) in swine, but it is not effective against thorny-headed worms, nodular worms, or whipworms.

When necessary, pigs may be treated with sodium fluoride at between eight and sixteen weeks of age, and again between four and six months of age. The drug should not be used as a worm remedy for breeding stock in herds where treatments have to be repeated frequently.

Commercial grades of sodium flouride contain 73% of the chemical, while other more highly refined preparations may contain 95% pure sodium fluoride. When the latter preparations are used, dosages have to be reduced in proportion. Suitable preparations of the drug are available, under trade names, in packages made up especially for swine. These packages of the powder, approved and licensed for sale in Canada, should be used in accordance with the directions on the labels.

No fasting or purging is necessary prior to, or after, treatment with sodium fluoride. It was, at first, recommended to be used at the one per cent level. but is safer to use at the three-quarter of one per cent level. Three-quarters of a pound of sodium fluoride is mixed with one hundred pounds of dry ground grain, the total amount prepared being that which the pigs will consume in one day. Usually, half the amount of the medicated food is given in the morning, and the balance in the evening feedings.

Sodium fluoride must not be given with wet mashes or in swill. It is highly poisonous to man and other animals. Poisoning symptoms in pigs are vomiting, soft faeces, diarrhoea, loss of appetite, and death. Care should be taken, to keep the chemical out of skin wounds.

Oil of Chenopodium, or Oil of American Wormseed, has long been used for large intestinal roundworm control in pigs. Experimentally, it has been demonstrated to remove 74% of the worms. The administration of chenopodium is preceded by starving the animals for eighteen to twenty-four hours. The dose is one-half to one fluid dram (2-4 cc.) for a one-hundred-pound animal, or in proportion.

Chenopodium is most effective when administered in individual doses by syringes, stomach tubes, or capsules. It may also be given in wet mashes to small groups of not more than six pigs. Mass treatments save labour, but make it difficult to control the amount which individual pigs receive. The administration of chenopodium is accompanied, or followed, by two fluid ounce (60 cc.) doses of castor oil for each hundred pounds of body weight, but additional cathartics should be given if the bowels do not move within an hour.

A useful mixture, combining the worm remedy and purgative into a single dose, is composed of oil of chenopodium, five parts, and castor oil, 95 parts. The dose, after an overnight fast, is two to three teaspoonsful for five-week-old pigs; six to eight teaspoonsful for eight-week-old-pigs; three to four teaspoonsful for 12-week-old pigs, and seven tablespoonsful for adult pigs. The maximum dose of oil of chenopodium for any pig should never exceed 12 cc., and it should not be given to pregnant sows within sixty days of farrowing. Water and feed are not given until three hours after treatment.

Phenothiazine is 92% effective against nodular worms, but only to variable degrees against large intestinal roundworms in swine. The drug has but little effect on immature roundworms, so its use is best confined to pigs three months or more old. It should not be given indiscriminately to pigs under four weeks of age or to sows near farrowing time.

Phenothiazine may be given in capsules or mixed with the feed. There are, also, other forms in which this drug is available. For individual treatments, the weights of pigs should be known and doses measured accurately. Doses are five grams for 25-pound pigs; eight grams for 25- to 50-pound pigs; 12 grams for 50- to 100-pound pigs, and 20 grams for 100- to 200-pound pigs.

For heavy breeding stock, phenothiazine may be given at the rate of 0.1 gram per pound of body weight; the full dose for individuals should be given, thoroughly mixed, in a pound of tankage. Thirty grams is the maximum dose for pigs weighing over 200 pounds.

For mass treatments, one-quarter of a pound of phenothiazine, mixed with sufficient feed for one meal, treats 35 thirty-pound pigs, 25 forty-pound pigs, or 20 fifty-pound pigs.

Mass treatment to large groups of pigs with phenothiazine may lead to loss, since some pigs will get more than the intended share of the medicated feed. When it is decided to administer phenothiazine to worm-infested pigs by mixing the drug in the feed, the following factors should be kept in mind: (1) the mixture of phenothiazine and feed should be "stiff," not sloppy; (2) the number of pigs in the pen at one time should not exceed six; (3) the pigs should all be the same size or weight, and have equal fighting ability to ensure that each one gets an equal share; (4) feed troughs that are sectioned to prevent greedy feeding are an aid in ensuring an equal share for each pig; (5) the medicated feed should be placed in the trough in a way such as will permit all pigs in the group to start at exactly the same time; (6) it is not necessary to starve or withold feed from pigs that are listed for treatment with phenothiazine, since pigs will take it readily in their usual feed; (7) the medicated feed should be evenly distributed in the feed trough before the pigs are admitted—trouble is likely to follow any carelessness that will permit overdosing with phenothiazine; (8) the correct amount of phenothiazine must be thoroughly mixed with the feed and fed at once; (9) pigs should not be exposed to the sun for 24 hours following treatment with phenothiazine.

Carbon Tetrachlorethylene is effective against large intestinal roundworms and hookworms. It is better suited to pigs under fifty pounds in weight than either oil of chenopodium or phenothiazine.

The drug is administered in capsules by those skilful enough to perform the task. The dose for pigs weighing up to 50 pounds is 1 cc.; up to 100 pounds, 2 cc.; up to 200 pounds, 5 cc. and up to 500 pounds, 10 cc. Capsules which burst in the mouths or lodge in the pharyngeal recesses may cause deaths by asphyxiation.

Carbon Disulphide, Hexylresorcinol, and Sulphonamides are effective respectively in the control of thick and red stomach worms, nodular worms, and coccidia. However, these drugs, together with phenothiazine and carbon tetrachlorethylene, should be used only on a veterinary surgeon's advice.

Miscellaneous

No satisfactory drug treatments exist to eradicate in swine, larval tapeworms, gullet worms, thorny-headed worms, whipworms, lungworms, garbage worms, kidney worms, or pork muscle fungi. All these infestations, however, may be reduced or controlled by sanitation. (See Ontario Department of Agriculture Bulletin No. 496, "Internal Parasites of Swine".)

EXTERNAL PARASITES

The two most common external pests of swine are lice and mange mites

In addition, pigs are occasionally parasitized by the maggots of flies which become established in neglected injuries, and sometimes by ticks. On occasions, the grubs of the horse bot flies have been found in pigs. Compared to other animals, swine have relatively few varieties of external pests.

Hog lice

The most widespread of the swine parasites is the common hog louse, which is easily seen about the ears, in the folds of the skin, and on the backs and sides of the infested animals. The lice are found on pigs throughout the year, but are most abundant in the winter months. Hog lice puncture the skin, suck blood, and cause irritation and itching. Infected animals are constantly scratching and rubbing themselves with the result that the hair is broken and wounds are made on the skin, which, in the warm weather, may become fly-blown. Hog lice transmit swine fever by passing from dead pigs to healthy ones. The lice attach their eggs to the hairs, the eggs hatch, and the young lice soon develop to maturity. Lice never leave the body of a live pig, except by accident when in contact with other pigs. There is little excuse for the presence of these pests in well-managed piggeries; they can be kept under control, or completely eradicated, if new stock is treated and pigs are regularly inspected and deloused. Special precautions should be taken when sows are bred to outside boars.

Lindane, used as a spray, dip, or dust, in strengths recommended by the manufacturers, will give simple and effective control. The Lindane spray recommended for hog mange may be used for lice also, and is applied at the rate of one quart per 200 pound animal. One per cent Lindane is used in dusts. Toxaphene, D.D.T., and other insecticides recommended for the purpose may be used with the manufacturer's precautions. Many of the older hog lice remedies, although messy and involving more work to apply, are economical and useful. Among these, crude oil applied with brushes or swabs is cheap and highly efficient. Home-made oilers, consisting of posts or sacks soaked in used motor oil, will be readily rubbed by pigs infested with lice. Oily preparations are best applied in the evenings, since exposure to the sun may result in blistering. A kerosene emulsion, made by dissolving 8 ounces of laundry soap in 1 gallon of boiling water and then adding 2 gallons of kerosene, makes a stock emulsion. To each part of the mixture, 9 parts of soft water are added before the mixture is applied to the pigs. Dips of creolin, lysol, and similar coal-tar preparations may be used in strengths recommended on the labels. Whatever treatment is used should be repeated at 8 or 10 day intervals until the lice are eradicated.

Mange in swine may be caused by two types of mites. The demodectic mite usually starts on the snout or eyelids and spreads backward. This type of mange, a condition which is fortunately rare in Ontario, is characterized by a scurfy, red skin and small, hard lumps, generally reddish and filled with pus and mites. Treatment for demodectic mange is difficult and usually impractical. The hides of pigs infected with this type of mange are of little use for leather.

The more widespread and common type of mange is caused by sarcoptic mites. Like all such mites, they are minute in size and make burrows in the skin in which they deposit eggs. Young mites soon emerge and, in their turn, multiply. Mange is most likely to occur in winter. Early lesions are seen near the ears, inside the forelegs, or along the belly. Itching becomes intense and is associated with inflammation, swelling, and blistering of the skin. As the disease progresses, the hairs drop out and the skin becomes scurvy, thickened, and wrinkled.

Lindane is the most satisfactory preparation to use against common mange mites. It is recommended at the rate of 2 pounds of 25% wettable Lindane in 100 gallons of water as a spray which should be used at the rate of 1 or 2 quarts per animal. The spray is applied, preferably, with a nozzle pressure of 350 pounds per square inch or higher. Although one treatment may suffice, repetition may be necessary at such times as are indicated for louse control.

For mange dips, 10 ounces of 25% Lindane wettable powder in 100 gallons of water are recommended. Infected pigs should not be dipped within two months of slaughter. Common hog mange may also be controlled with single, crude-oil dips. Lime and sulphur dips, which usually have to be repeated at weekly intervals for four weeks, are also effective when they are applied between 95°F. and 100°F. and the animals are held in the dips for three minutes.

An important part in the eradication of mange is the cleaning up and disinfection of the premises which have housed mangy animals. Suitable disinfectants are 5% solutions of carbolic acid or 2% dilutions of creosol. There are also many good commercial products on the market. Mange in swine is not a reportable disease, and its control is entirely up to the hog producer.

Common mange must be differentiated from various other skin diseases, some of which are contagious and will not respond to the treatments enumerated previously. When one is in doubt as to the true nature of skin Lesions, it is advisable to have the herd examined by a veterinarian and, if necessary, have him make laboratory cultures and microscopic examinations of suitable skin scrapings.

Good feeding, cleanliness, and frequent inspections of the swine stock will reduce or eliminate losses from external parasites.

Fly control in piggeries demands constant attention throughout the summer months. Of primary importance is the frequent disposal of manure, offal, garbage, and all other waste materials to which flies are attracted or in which they breed. Wherever practical, fly screens should be put on doors and windows. Knock-down and residual sprays, traps, poison baits, and other devices may be used. (In some areas flies have become resistant to D.D.T. and similar insecticides). Inasmuch as flies are a continual nuisance and transmit disease, all efforts made to reduce their number are well worthwhile.

BULLETIN 501 JANUARY, 1955

FARM DRAINAGE

ONTARIO AGRICULTURAL COLLEGE

GUELPH, ONTARIO

ONTARIO DEPARTMENT of AGRICULTURE
PARLIAMENT BUILDINGS, TORONTO, CANADA

By F. L. FERGUSON, Associate Professor
Department of Agricultural Engineering

DRAINAGE IS AN INVESTMENT

From a financial standpoint, underdrainage must be considered as a long term investment. Tile drainage of agricultural lands is a comparatively expensive improvement and the capital expended in drainage cannot be recalled or transferred, but owing to the permanent nature of the work, properly installed drainage systems should continue to return dividends for many years. Just how many years is problematical, but in a general way tile drains may be said to last a lifetime. Drainage, unlike most other long-term investments, will often pay dividends sufficient to return the original capital in two or three years.

ALL SOILS NOT NATURALLY DRAINED REQUIRE DRAINAGE

These generally exist as:

1. Cultivated areas with fair surface drainage but having a heavy clay subsoil.

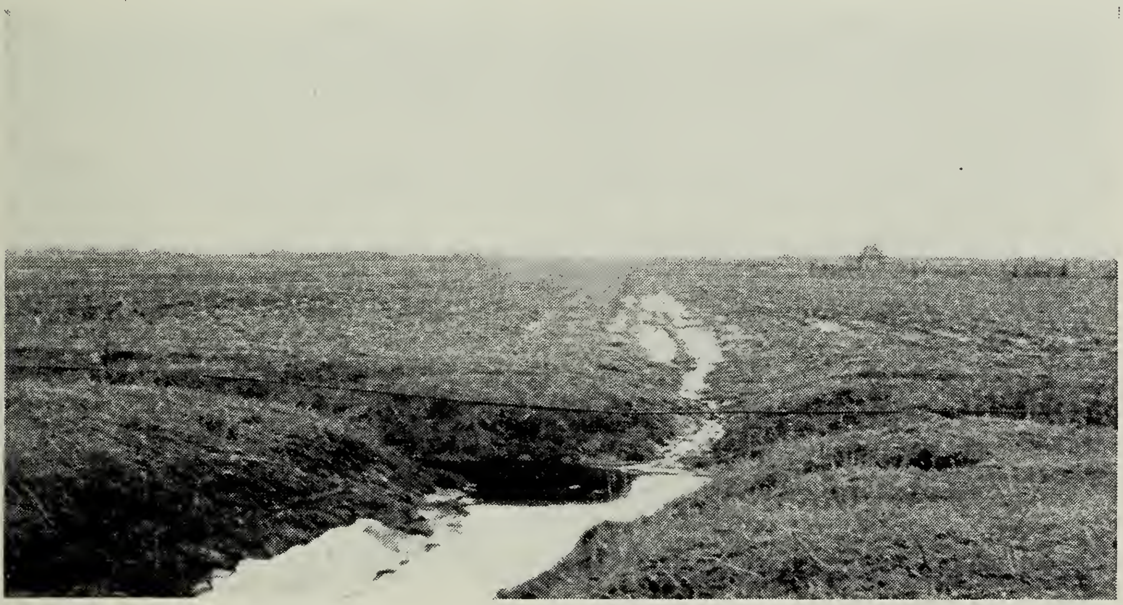


Fig. 1.—Is it practical to let a wet field like this delay spring seeding?

2. Heavy clay soils with very little or no surface drainage.
3. Rolling areas with an impervious subsoil.
4. Areas, large and small, saturated long enough each year to destroy the physical condition of the soil, interfere with spring seeding and harvesting operations.
5. Pot-holes and swamp areas.

INDICATIONS OF TILE DRAINAGE REQUIREMENTS:

1. Free water standing on the surface or in excavations in the subsoil.
2. The tendency of a soil to puddle when wet and bake when dry.
3. The accumulation of organic matter—swamp areas.
4. A miry condition in the spring and after rains.
5. The killing out of crops, and the growth of weeds which will stand wet soil conditions.
6. The heaving of clovers and winter grain crops.
7. The stunted appearance of many crops, with curled wilted leaves.
8. In orchards—weakened and missing trees.

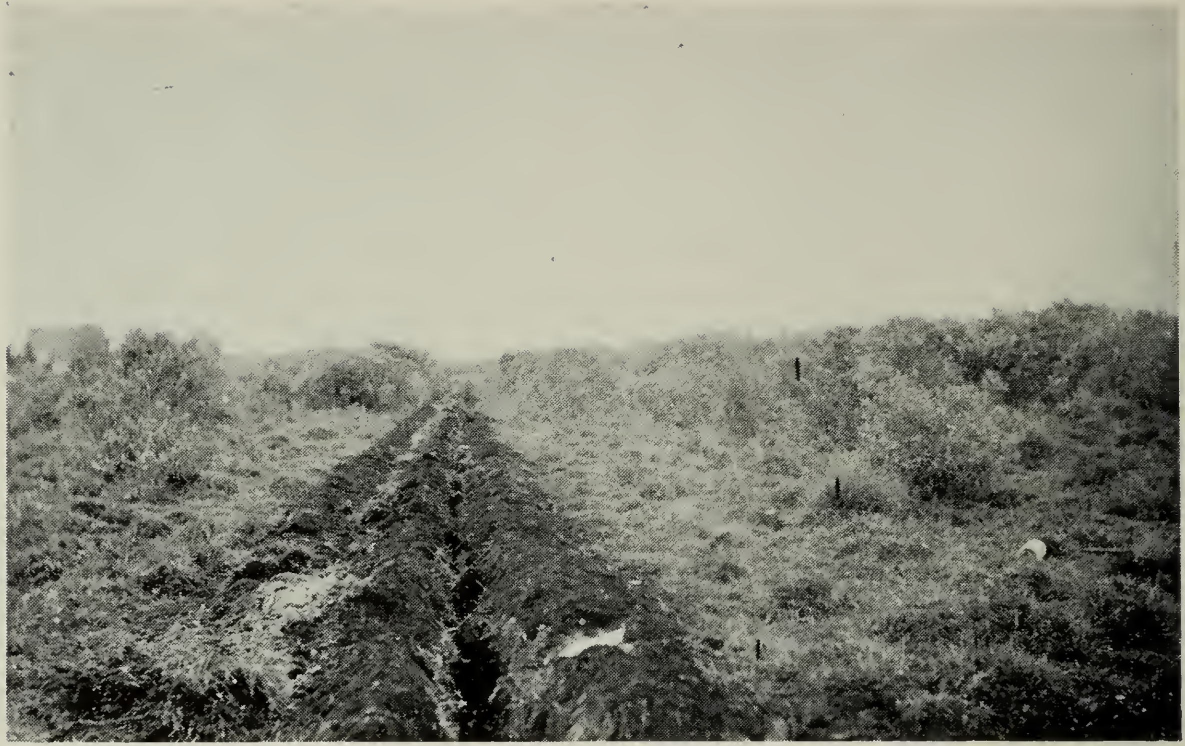


Fig. 2.—A swamp area tile drained in 1925 which has given a real crop every year since. The first crop paid all drainage expenses.

DRAINAGE INCREASES FARM CROP YIELDS

1. Earlier spring seeding and a longer growing season are permitted.
2. The land is more easily worked and implements are more effective.
3. Germination percentage is higher.
4. Soil is more favourable for root development, hence more moisture and plant food are available. See Fig. 3.
5. Air circulation is improved.
6. A higher average temperature is maintained.

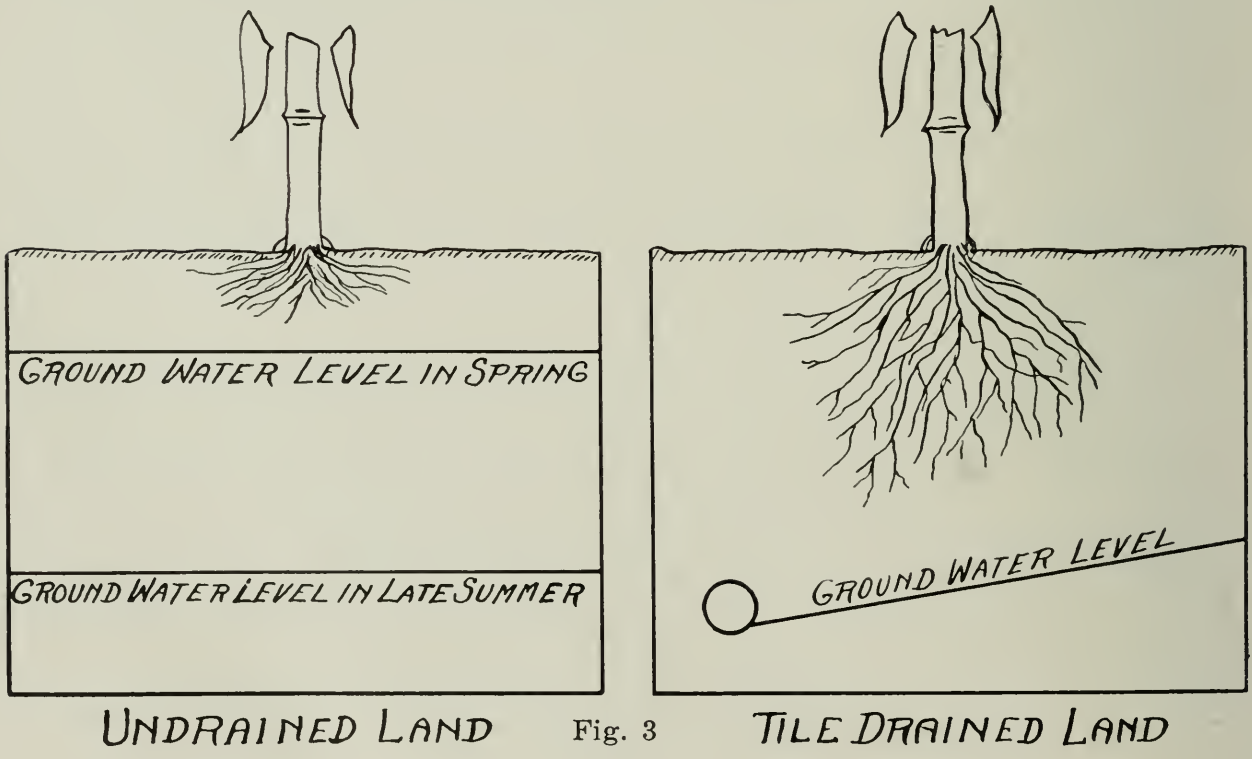

GROUND WATER LEVEL IN SPRING
GROUND WATER LEVEL IN LATE SUMMER
UNDRAINED LAND
GROUND WATER LEVEL
TILE DRAINED LAND

Fig. 3

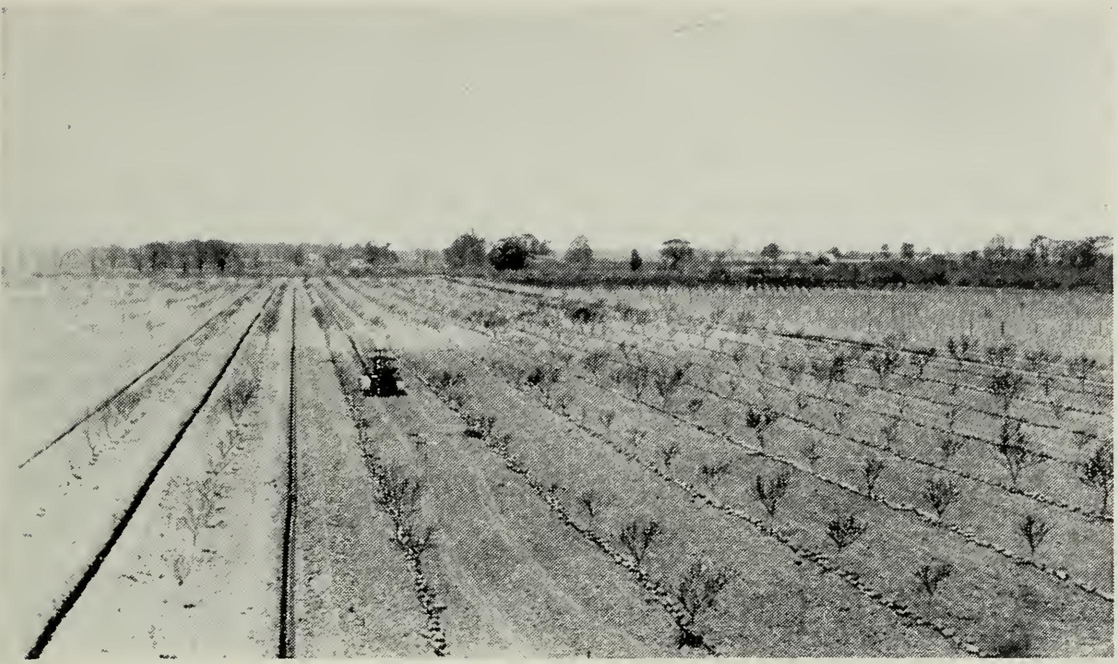


Fig. 4.—For peach orchards drainage is essential.

7. Soil fertility is improved because of increased chemical and bacterial activity.

8. Erosion and heaving are reduced.

9. The improved physical condition permits the retention of more capillary moisture.

10. Winter killing in orchards is greatly reduced. See Fig. 5.

11. Orchard spraying is facilitated.

12. Weeds are more easily controlled.

13. Property is often made more attractive.

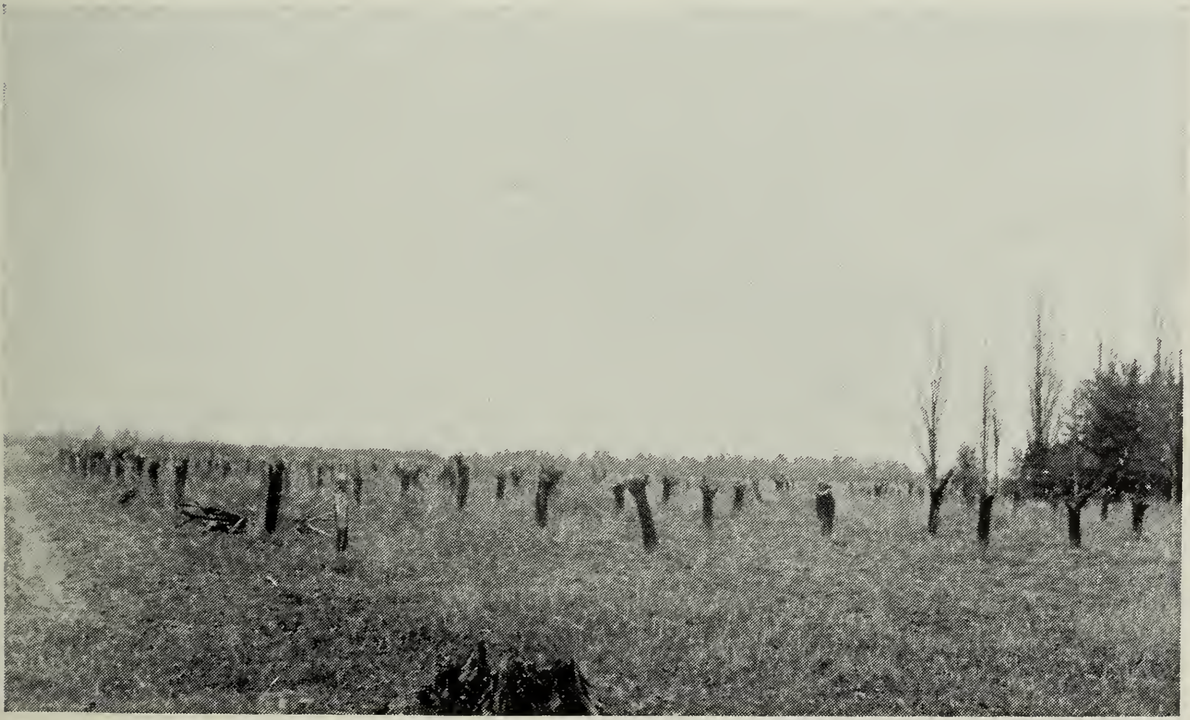


Fig. 5.—A peach orchard—the result of poor drainage.
Thousands of trees in the Niagara district have been killed in this manner.

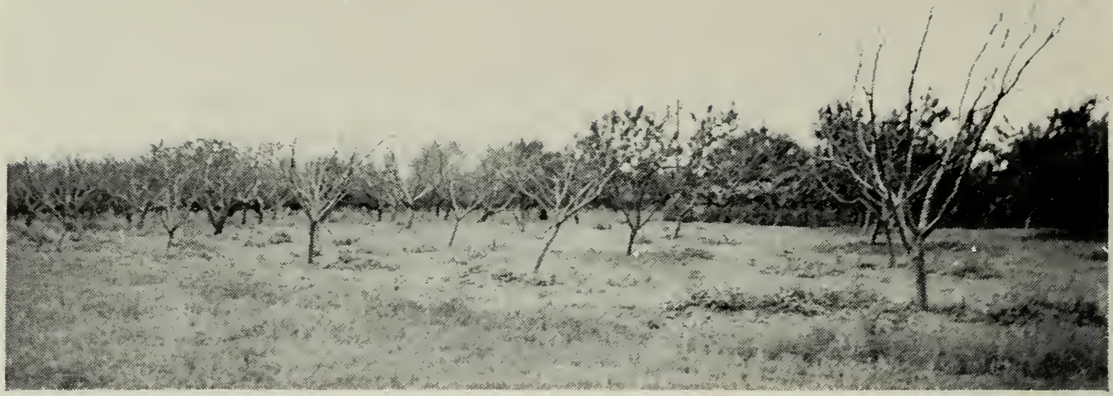


Fig. 6.—In this peach orchard the first drain was placed between the second and third rows of trees instead of between the first and second, with the result that the first row died because of the wet conditions.

HOW SHOULD DRAINAGE WORK BE ACCOMPLISHED?

Whether the area to be drained is large or small, or whether one drain or many are required, it is generally advisable to have a survey made.

The plan when prepared will show:

1. The proper location for all mains, sub-mains and laterals.
2. The number and size of tile for each drain.
3. The possible grades and depths.
4. The best possible outlet.
5. The locations of all obstructions, buildings, trees, fences, etc.

With this information at hand, the farmer is in a position to put in as much as his time, help or financial circumstances permit. The main drains should be installed first and the others added when conditions permit. Further, he can now let a contract and has a basis on which to calculate the cost of his system.

Because the same area often lends itself to different drainage schemes, the most economical system can be chosen. See Fig. 8.

In laying out a drainage system it is desirable to obtain:

1. Thorough drainage for the entire area.
2. A system requiring the least amount of digging and the smallest number of feet of tile.
3. As few outlets and junctions as are practical.
4. The minimum number of large tile.
5. Sufficient grade on the drains.
6. A system easily installed from a machine operator's point of view.

SIDE HILL DRAINAGE

Springs or seepage areas on side hills require careful consideration. Tile running directly up and down the hill do not work as effectively as tile run across the face of the hill. Frequently one line of tile 3 to 3½ feet deep above the wet area will cut off the water from the wet area and dry it up. If systematic drainage is necessary on a heavy slope, the tile should be run across the face of the hill and not up and down.

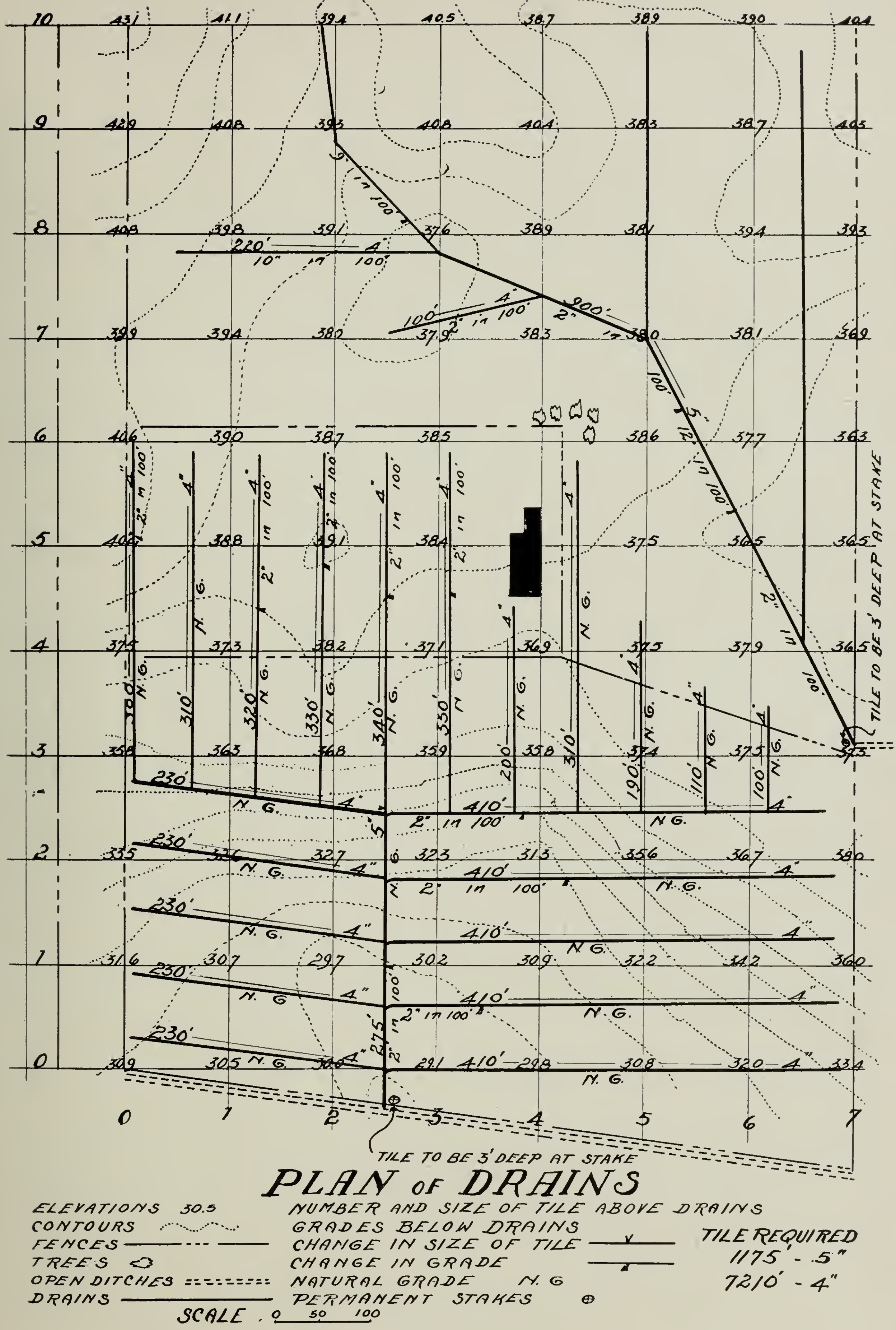
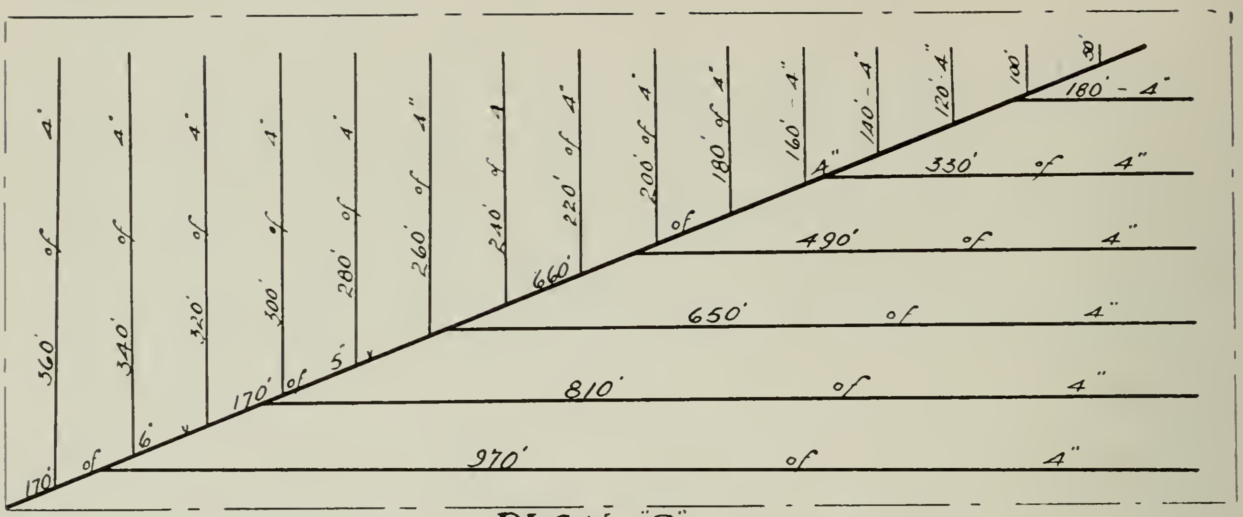
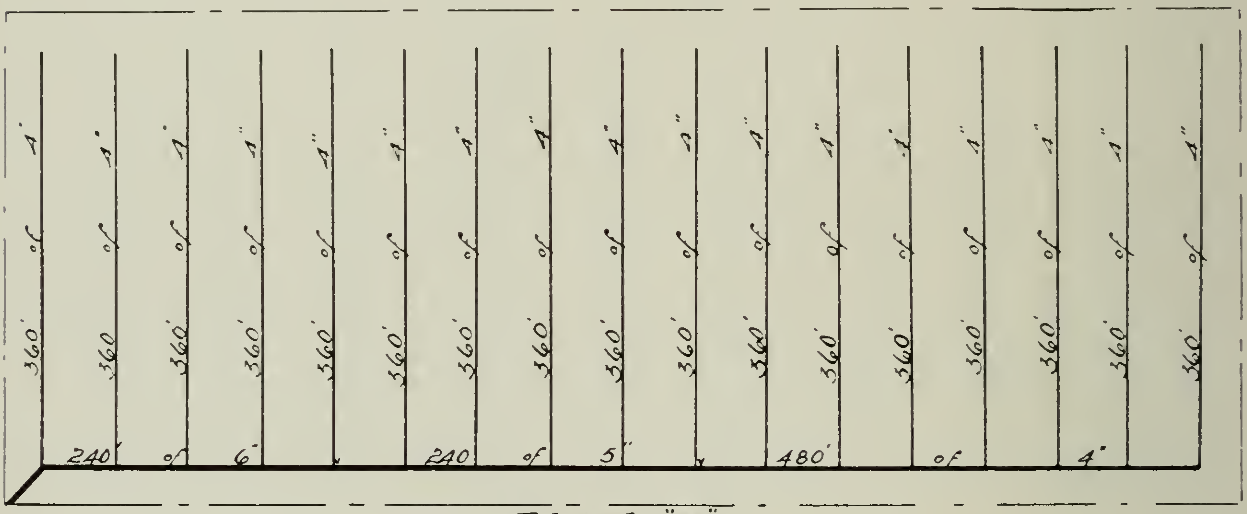


Fig. 7.

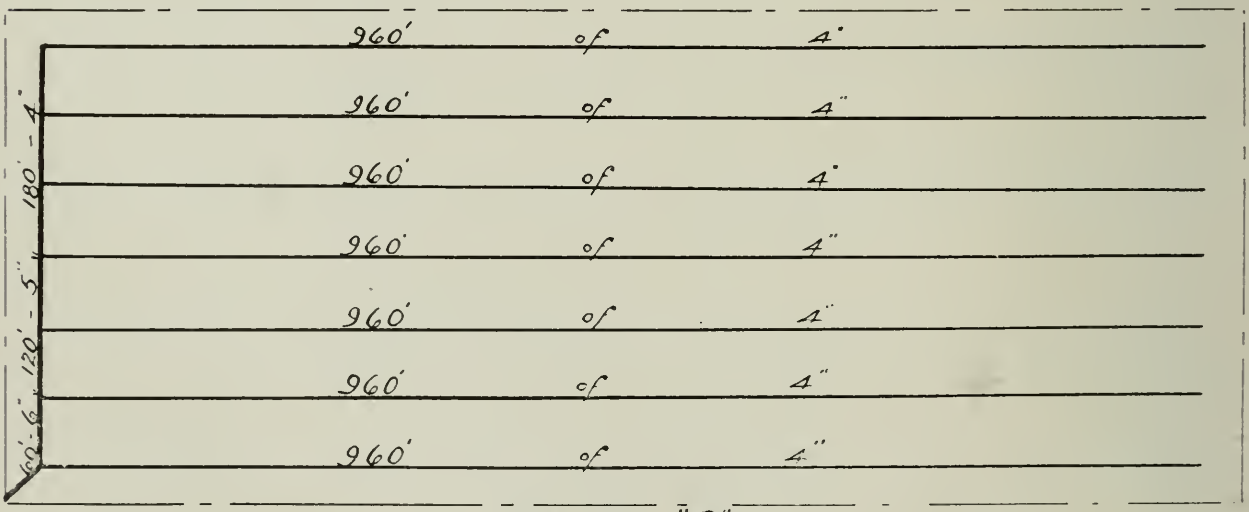
When a complete survey is made, drains to give the best results can be properly located.



PLAN "A"



PLAN "B"



PLAN "C"

Fig. 8.

In Fig. 8 three different methods of draining the same 10-acre field are shown. It is assumed that the slope of the land is equally favourable for any one of the three systems. Under any one of the systems shown, the field is thoroughly drained, but the cost of installation varies with each system.

Plan "A" (herringbone system) costs as follows for installation:

466 rods of digging at 65¢ per rod	$302.90
466 rods of backfilling at 4¢ per rod	18.64
7,360 feet of 4" tile at $50.00 per 1,000	368.00
170 feet of 5" tile at $75.00 per 1,000	12.75
170 feet of 6" tile at $100.00 per 1,000	17.00
21 junctions at 25¢ each	5.25
Total for 10 acres	$724.54

Plan "B" (gridiron system with long main and short laterals) costs as follows:

429 rods of digging at 65¢ per rod	$278.85
429 rods of backfilling at 4¢ per rod	17.16
6,600 feet of 4" tile at $50.00 per 1,000	330.00
240 feet of 5" tile at $75.00 per 1,000	18.00
240 feet of 6" tile at $100.00 per 1,000	24.00
17 junctions at 25¢ each	4.25
Total for 10 acres	$672.26

Plan "C" (gridiron system with short main and long laterals) costs as follows:

429 rods of digging at 65¢ per rod	$278.85
429 rods of backfilling at 4¢ per rod	17.16
6,900 feet of 4" tile at $50.00 per 1,000	345.00
120 feet of 5" tile at $75.00 per 1,000	9.00
60 feet of 6" tile at $100.00 per 1,000	6.00
7 junctions at 25¢ each	1.75
Total for 10 acres	$657.76

From the above figures it can be seen that Plan "B" costs $52.28 less to install than Plan "A". Plan "C" costs $66.78 less to install than Plan "A". Furthermore, Plan "C" is a much less difficult system for the machine operator to install because of longer lines and fewer junctions.

A study of these plans shows the advantage of having a drainage survey made by a competent surveyor, whose duty it is to determine the most efficient and most economical system possible.

FIELD ASSISTANCE

The Department of Agriculture, through its Departments of Agricultural Engineering at the Ontario Agricultural College and at the Kemptville Agricultural School, or the Agricultural Engineering Fieldmen of the Agricultural Representative Branch, will upon application send a man to survey for the drainage work. Applications for surveys must be made through the office of the County Agricultural Representative.

FINANCIAL ASSISTANCE NECESSARY

The cost of drainage work depends on a number of local conditions:

1. Whether the system required is of systematic design or whether only a few lines of tile are required.

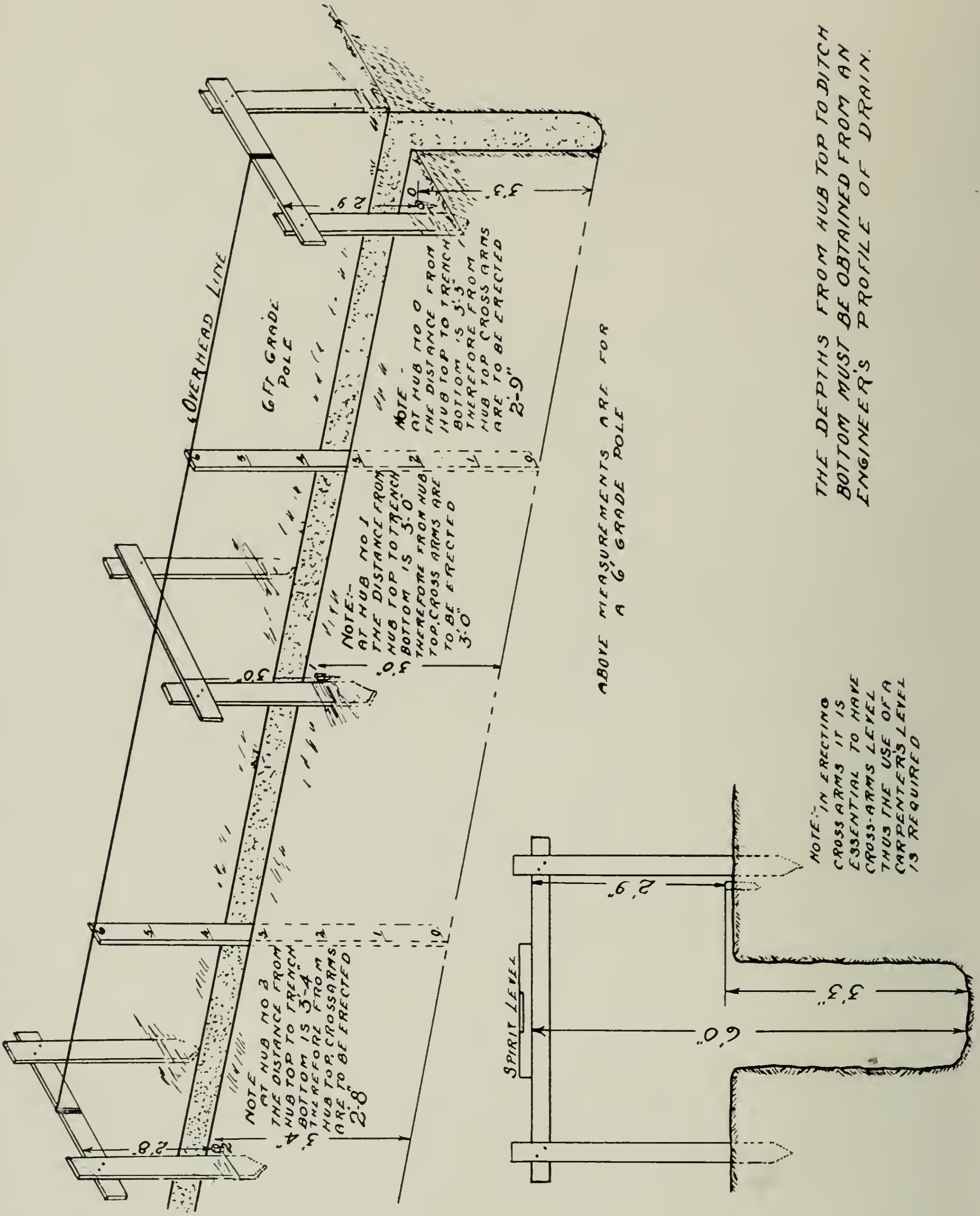

OVERHEAD LINE
6 Ft GRADE POLE
NOTE - AT HUB NO 0 THE DISTANCE FROM HUB TOP TO TRENCH BOTTOM IS 3'3" THEREFORE FROM HUB TOP CROSS ARMS ARE TO BE ERECTED 2'-9"
2'9"
3'3"
NOTE:- AT HUB NO 1 THE DISTANCE FROM HUB TOP TO TRENCH BOTTOM IS 3'0" THEREFORE FROM HUB TOP, CROSS ARMS ARE TO BE ERECTED 3'0"
3'0"
3'0"
NOTE AT HUB NO 2 THE DISTANCE FROM HUB TOP TO TRENCH BOTTOM IS 3'4" THEREFORE FROM HUB TOP, CROSSARMS ARE TO BE ERECTED 2'8"
2'8"
3'4"
5
4
3
2
1
0
ABOVE MEASUREMENTS ARE FOR A 6' GRADE POLE
THE DEPTHS FROM HUB TOP TO DITCH BOTTOM MUST BE OBTAINED FROM AN ENGINEER'S PROFILE OF DRAIN.
SPIRIT LEVEL
2'9"
3'3"
6'0"
NOTE:- IN ERECTING CROSS ARMS IT IS ESSENTIAL TO HAVE CROSS-ARMS LEVEL THUS THE USE OF A CARPENTER'S LEVEL IS REQUIRED

Fig. 9.—The Over-head Line—a most accurate and easy method of grading a drain when hand construction is necessary. The Agricultural Engineering Department, O.A.C., will furnish further details with regard to its use.

2. The nature of the crops grown.
3. The condition of the soil for digging.
4. The location of the tile plant.
5. Whether or not power machinery is available.

The Tile Drainage Act makes government loans available for drainage purposes. Briefly, this Act provides for a loan which is obtained through the municipal council for 75% of the cost of installing a drainage system. Money may be borrowed up to $3,000.00 per 100 acres or fraction thereof. The loan is refunded over a period of ten years at an interest rate of 4%. This means that an annual payment of $12.33 for every hundred dollars borrowed retires both principal and interest over a ten-year period.

For example, on a drainage system costing $75.00 per acre, ten annual payments of $9.25 per acre would be required to retire the loan. The Township Council is generally very glad to co-operate with ratepayers in respect to these loans.

INSTALLING THE TILE

Trenches may be dug either with a ditching machine or by hand. The machine when carefully operated is quicker, more efficient, and usually preferred on large contracts. Most machine operators are able to work from a survey blueprint. This blueprint serves as the basis for his contract. Generally, the farmer supplies and distributes the tile on the field convenient for the machine operator and backfills the trenches.

All machine-installed jobs should be inspected before the trenches are backfilled. This service can be obtained free of charge, upon further application.

HAND INSTALLATION

Hand construction is worthy of consideration where a ditching machine is not available and when only a limited amount of work is to be done. A man can dig ten feet an hour to a depth of three feet if the surface spading has been plowed out, and digging conditions are favourable.

It is advisable to have the drain surveyed, hub stakes located every hundred feet, and a profile prepared so that an overhead line, Fig. 9, can be erected. This insures proper depths, uniform grades, and leaves no doubt as to whether or not the drain will be satisfactory.

Machinery such as the ordinary plow, the Martin Ditcher, Fig. 10, or the Little Wonder Ditcher, Fig. 11, can be used to remove from 12 to 24 inches of earth from the trench. The rest must be removed by hand and the ditch bottom properly graded by the use of the overhead line. The ordinary tile spade and scoop will be found convenient for completing the trench.

The Little Wonder Ditcher, Fig. 12, when drawn by two three-horse

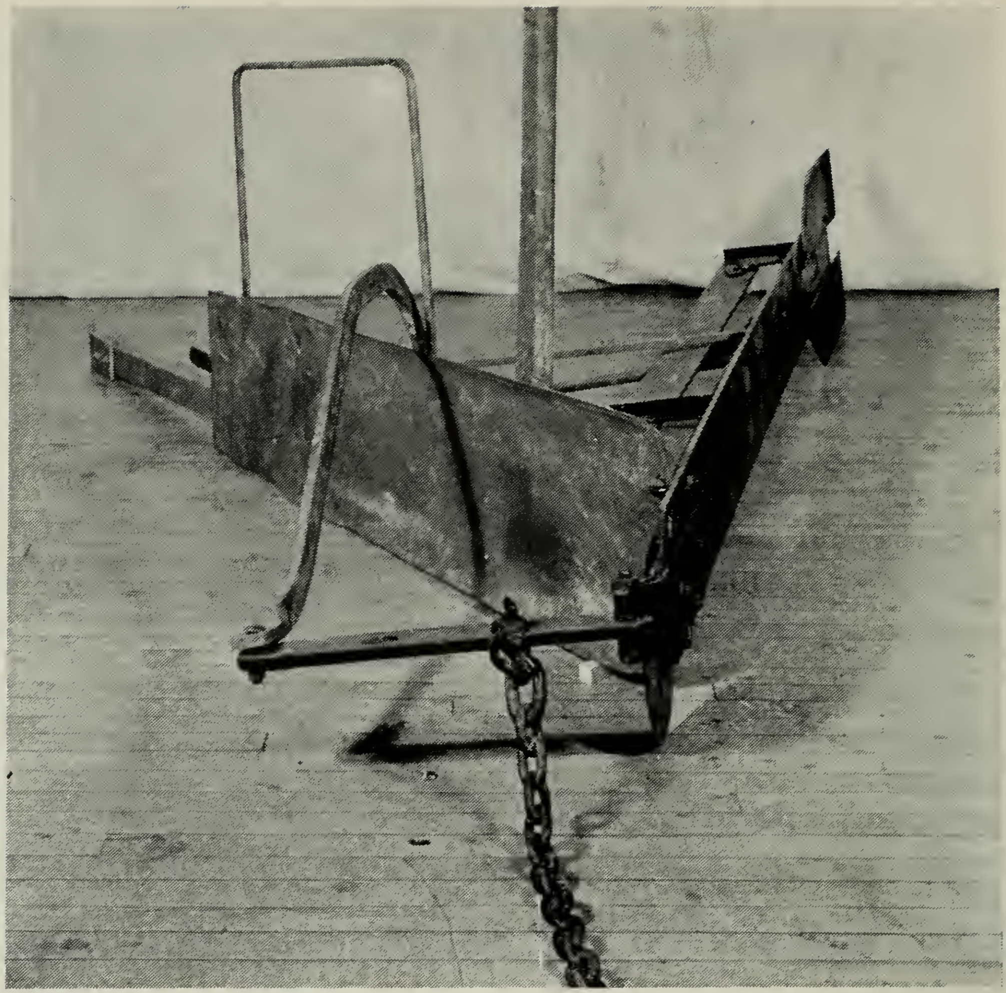


Fig. 10.—The Martin Ditcher.

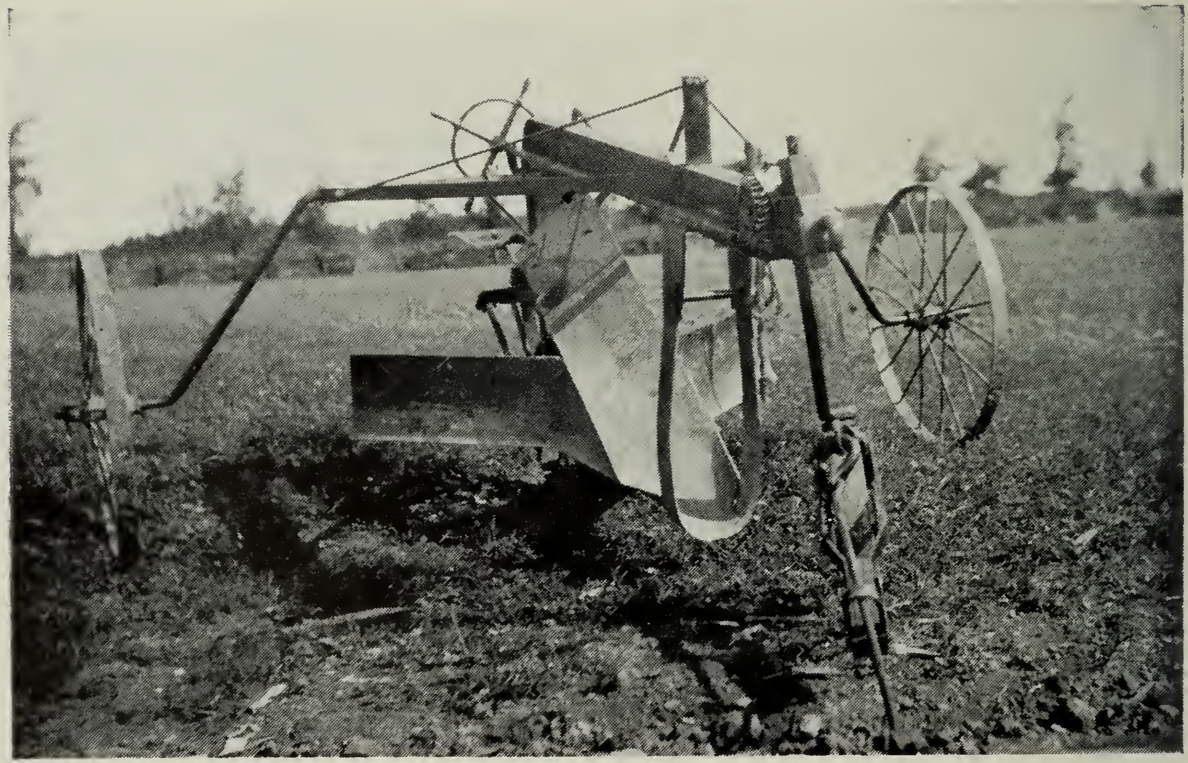


Fig. 11.—The Little Wonder Ditcher.

teams, or by two tractors, removes from 4 to 6 inches of soil each trip. It works best when the soil is moist and preferably in a sod field. A trench from 24 to 28 inches deep can be constructed.

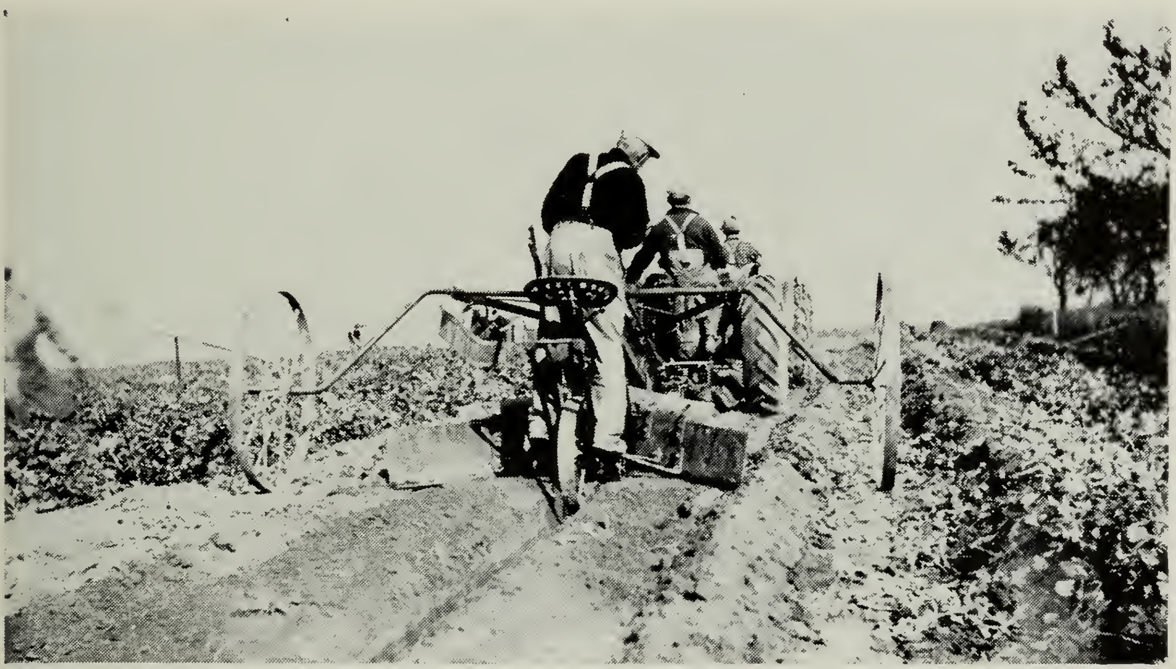


Fig. 12.—Constructing a trench with the Little Wonder Ditcher.

The Martin Ditcher, Fig. 10, constructs a V-shaped ditch. In favourable soil conditions most of the trench can be constructed with this implement.

Fig. 13.—When tile drains run near trees the tree should be destroyed or sewer pipe with cemented joints should be used for 50 feet on either side of the tree.

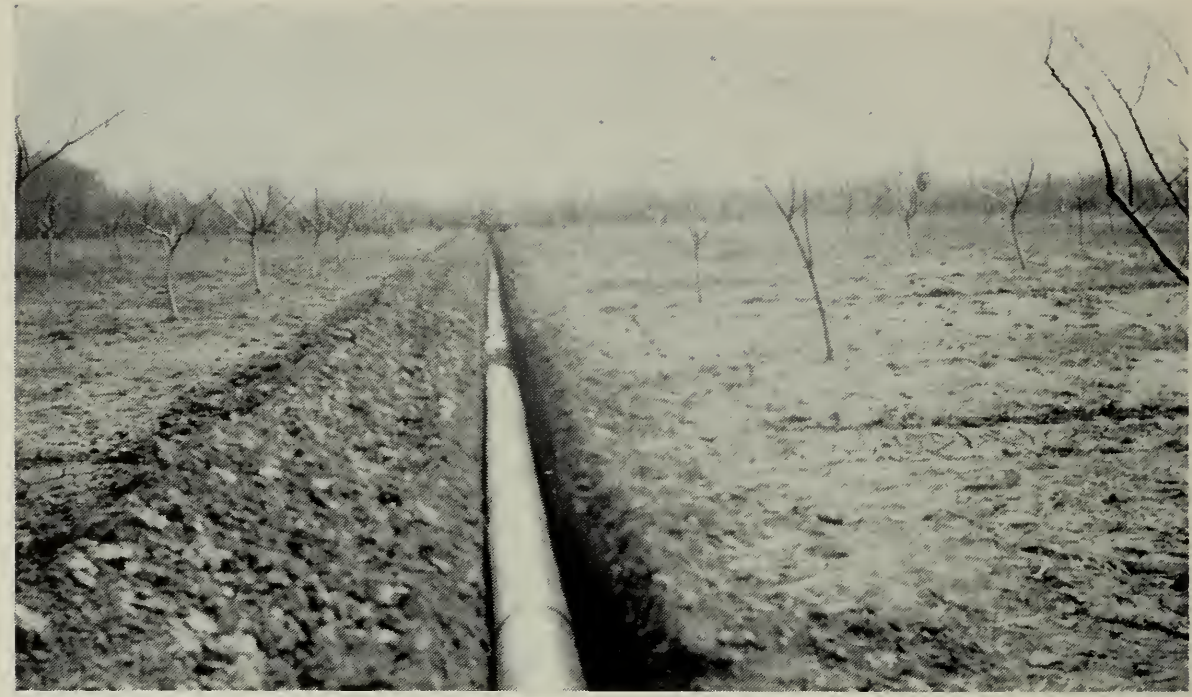


Fig. 14.—A properly graded straight trench with tile well laid facilitates the flow of the water.

In using machinery one must be careful not to disturb the hub stakes left by the surveyor.

The ditch should be constructed from the outlet. As soon as one portion is properly graded, the tile should be laid and blinded.

Whether trenches are dug with machines or by hand, the following points should be kept in mind:

1. The grade must be uniformly distributed so that depressions to collect sediment do not exist.

2. A solid bottom is essential—tiles laid on muck or soft material are likely to shift out of alignment and obstruct the flow of water.

3. The tile should be laid as soon as the trench is completed.

4. The stones or other obstructions encountered in the trench must be removed and the hole carefully filled and tamped to give a solid bottom.

5. Only the best tile should be used.

6. Blinding and back-filling must be done carefully to eliminate the breaking of tile by stones rolling into or by horses stepping into the trench.

7. Trees likely to block the tile must be removed.

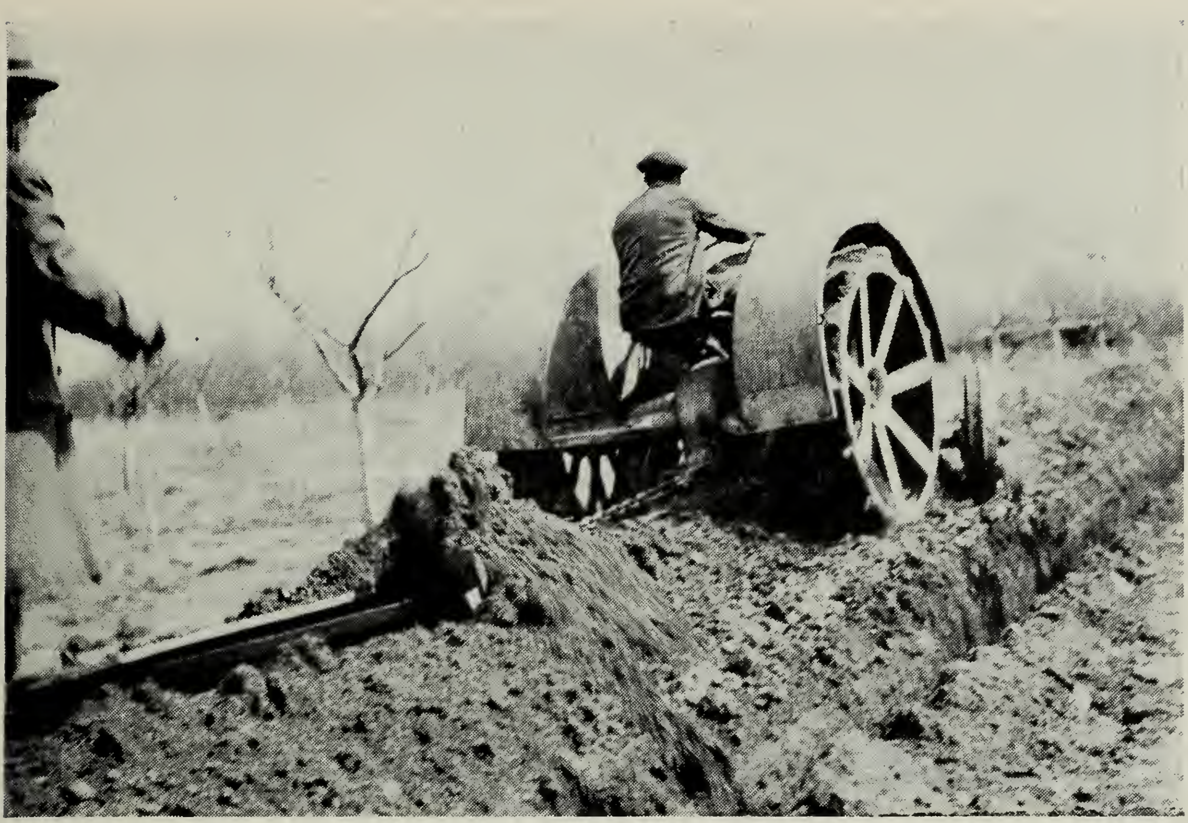


Fig. 15.—Martin ditcher used for backfilling. This is particularly well adapted in fruit orchards where the tree rows are narrow.

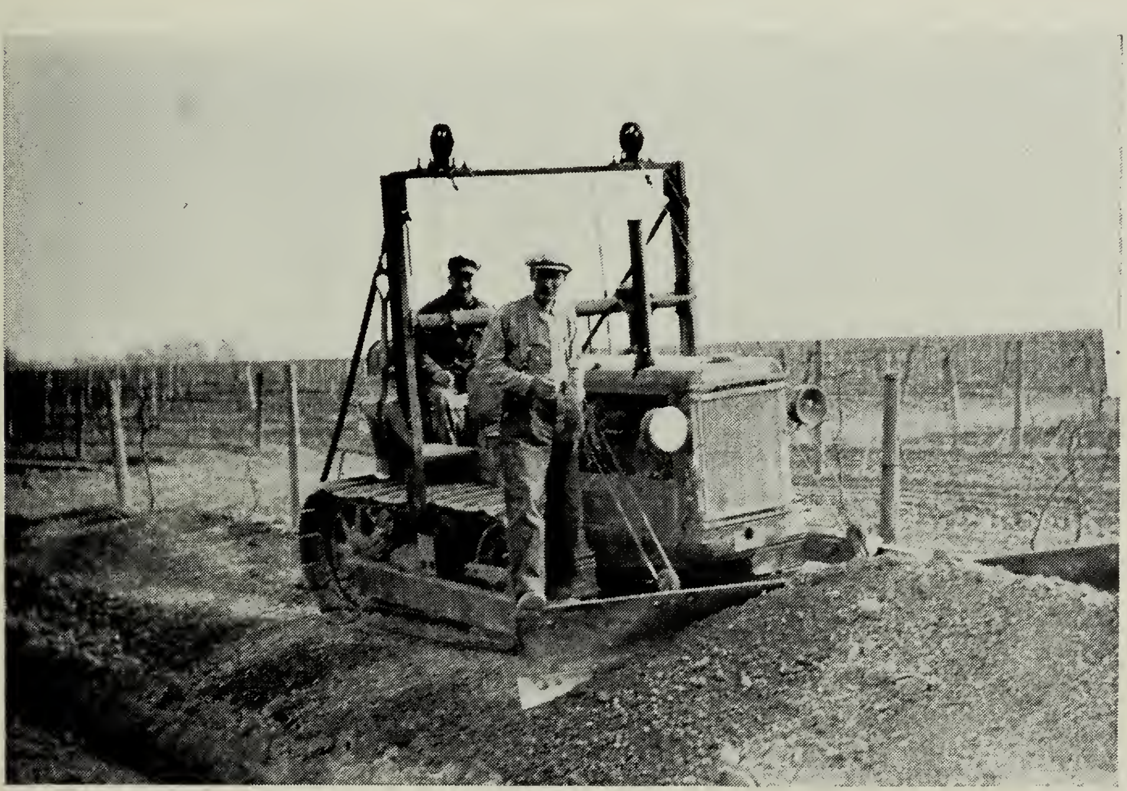


Fig. 16.—Using a bull-dozer for backfilling a trench.

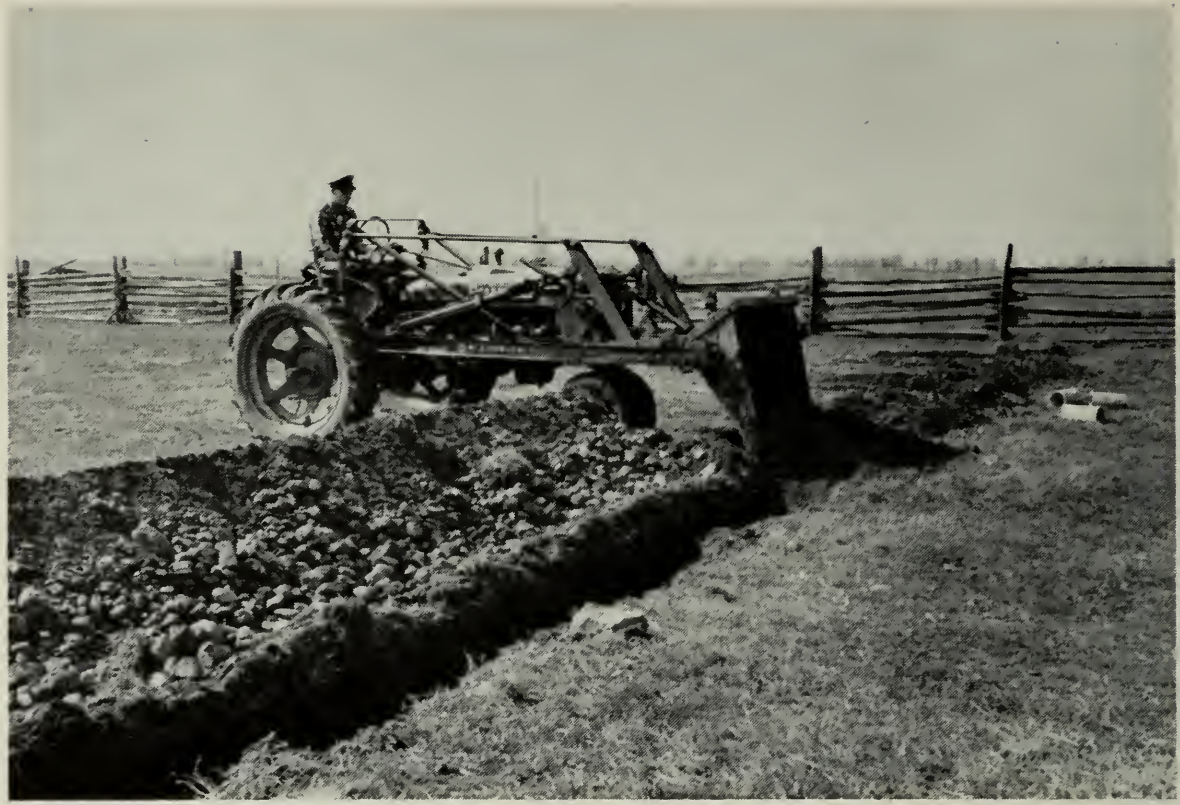


Fig. 16A.—Backfilling with specially equipped farm tractor.

LAYING TILE

Ordinarily, tile should be laid as closely together as the cut ends permit. In heavy clay soils a little opening is not objectionable, while in sandy or sandy loam soils it is necessary to fit them closely together. In the latter it is often desirable to cover the upper half of the tile with tar paper to prevent the sand from entering.

Whether the tile are laid by hand or with a hook is not important so long as they are kept in proper alignment and well graded.

A few inches of soil, preferably the surface soil, should be placed over the tile as soon as they are laid.

The upper end of a drain should be closed with a flat stone.

Backfilling should not be too long delayed, as frequently the soil will become baked and difficult to move.

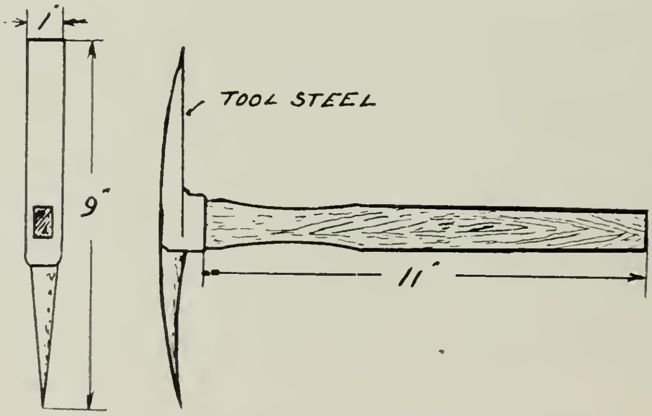


Fig. 17.—A tile pick.

JUNCTIONS

Junctions should be constructed carefully so that there is no resistance to the flow of water.

Moulded junctions can be obtained from many of the tile manufacturers. These are very satisfactory and desirable.

When making a junction one should obtain a tile pick. See Fig. 17. With this he can open a properly shaped hole in the side of the main tile equal to the diameter of the lateral tile, which is shaped, fitted up closely and covered with concrete. See Fig. 18.

SPACING AND DEPTHS

The depths and distances apart at which tile should be placed depend almost entirely upon the nature of the soil. In lighter soils the tile can be placed deeper and farther apart than in heavy clay.

QUICKSAND

Quicksand is perhaps the worst problem encountered in drainage. The following suggestions may be helpful:

1. Quicksand areas should be drained during the driest part of the season.

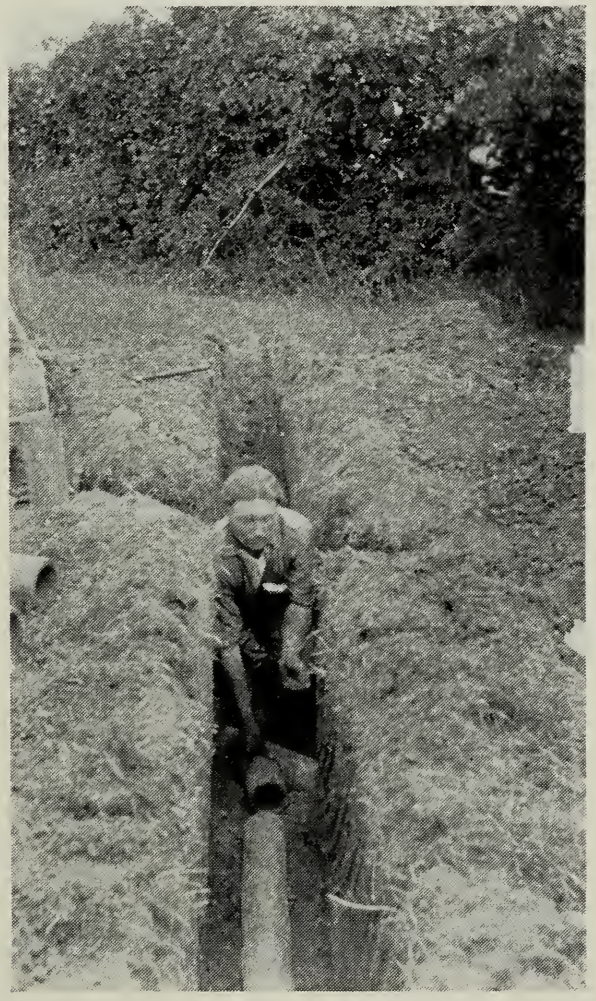


Fig. 18.—Constructing a "Y" junction. When the junction has been properly fitted, a tile is cut the proper length to fill the gap.

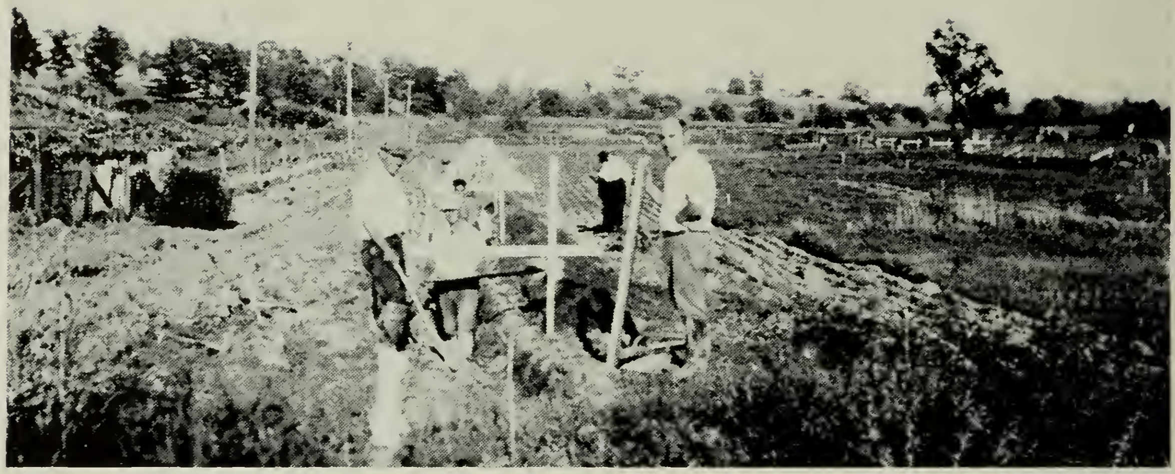


Fig. 19.—Constructing a ditch by using cross arms. See Fig. 9 for method of erection.

2. If possible, after the drain into the quicksand is opened it should be left until the water drains out. The sand will solidify and the drain may be more easily completed.

3. In some cases it is better to remove the last foot or so by hand, as the action of the digging wheels seems to provoke the trouble.

4. Sod thrown in the trench and around the joints is practical for short distances.

5. Straw, sawdust, shavings, gravel, and cinders are often used to good advantage.

6. Cemented sewer-pipe may be found practical in some conditions.

7. As soon as soil and field conditions permit after passing through a quicksand area, a silt basin should be constructed on the line of tile.

SILT BASINS

Silt basins are constructed for one or all of three purposes: to remove from the drainage water sediment which may lodge and block the drain; to afford a means of inspecting various sections of the system; to serve as a junction.

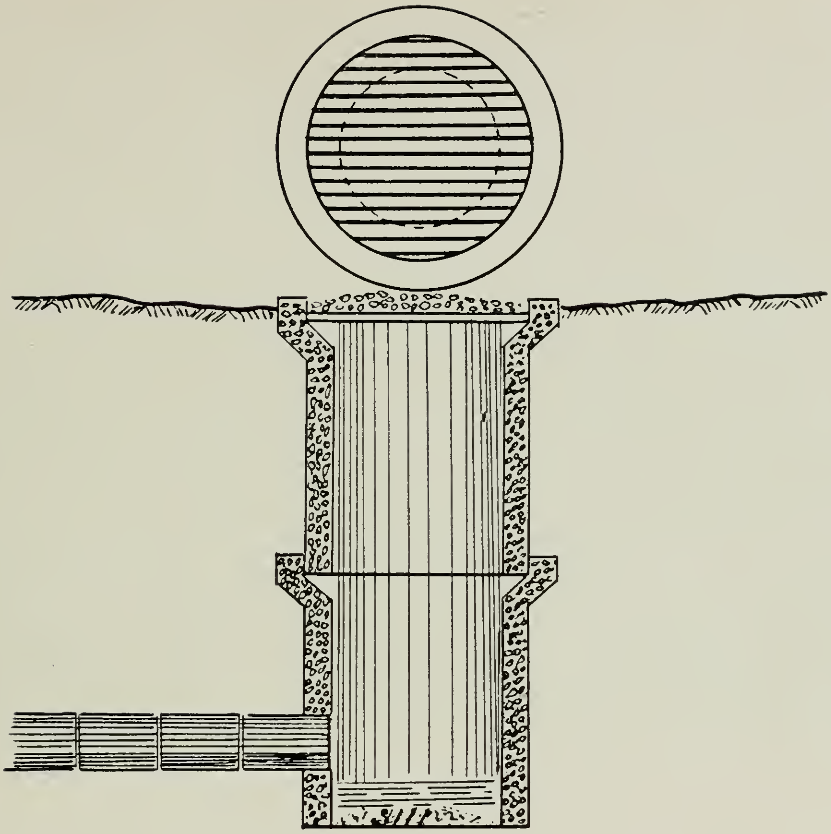


Fig. 20.—Catch basin constructed with culvert tile.

CATCH BASINS

Catch basins are designed to allow surface water to enter a tile drain. Many schemes have been used. The most common is the concrete box type with an iron grating. Culvert tile are also used.

ROOTS

Tree roots seldom interfere with a drain unless it is carrying spring or seepage water during the dry season.

It is advisable, however, to remove such trees as willow, elderberry, poplar, soft maple and elm from the location of the drain.

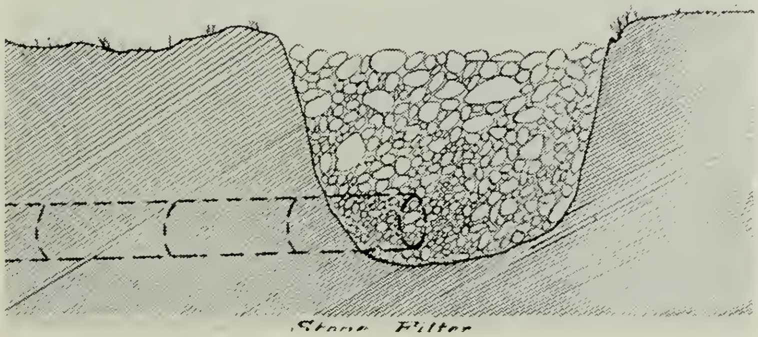


Fig. 21.—A stone filter for running surface water into a tile drain.

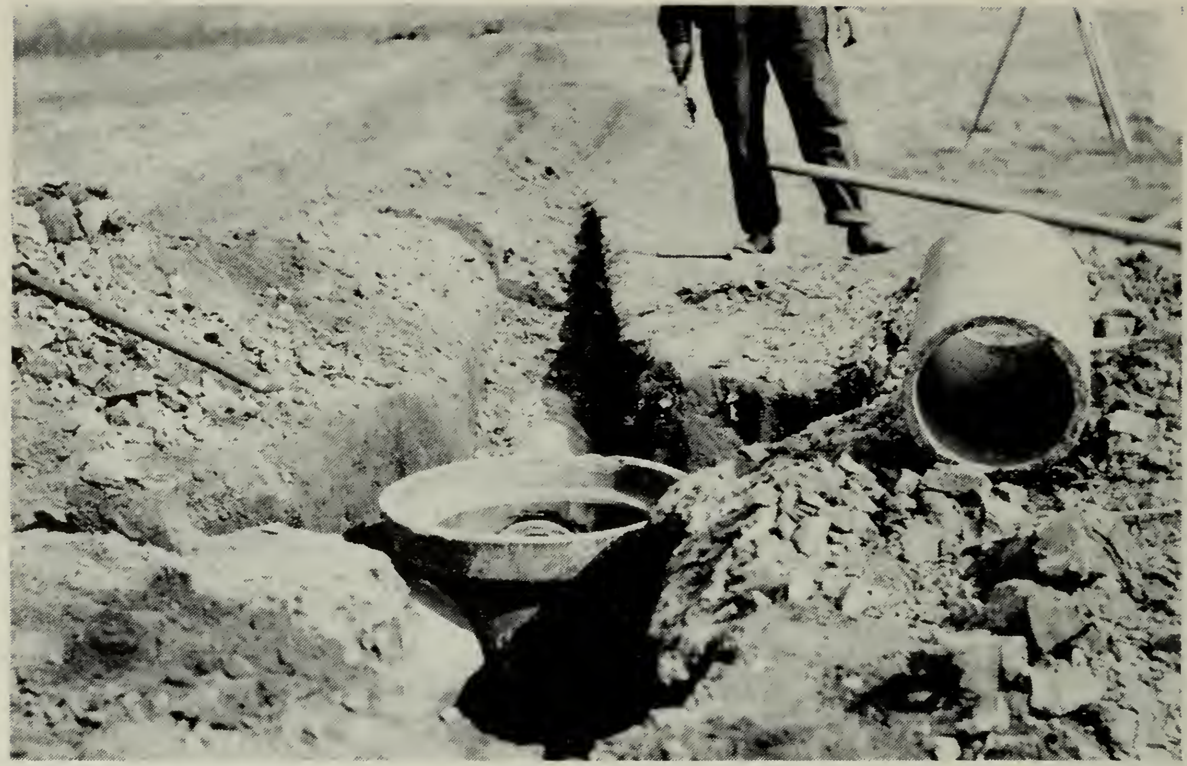


Fig. 22.—Culvert tile used for a silt basin.
A little experience is necessary in making openings.

When it is desirable to leave a shade tree, cemented sewer-pipe should be used for at least fifty feet on either side of the tree. See Fig. 13.

In fruit orchards and permanent crops, cut-off drains should be installed to remove all seepage water which has a tendency to feed the tile drain during the summer.

OUTLETS

The outlet of a drainage system should be well protected. The last eight or ten feet should consist of a piece of gas pipe, corrugated pipe, several lengths of sewer pipe or even a wooden box. A concrete retaining wall may be necessary. Some protection over the mouth of the tile to prevent the entrance of animals is essential.

TILE

Tile may be made of either clay or concrete. Both, when properly manufactured, give good results. They should exhibit the following qualities:

1. Smoothness, to reduce friction and promote rapid waterflow.

2. Hardness, to indicate durability—good shipping and handling qualities. The tile when struck with a piece of metal should give a distinct ring.

3. Tile should be well shaped—cylindrical, not warped, and have clean-cut ends.

4. Clay tile should be free from burnt limestone.

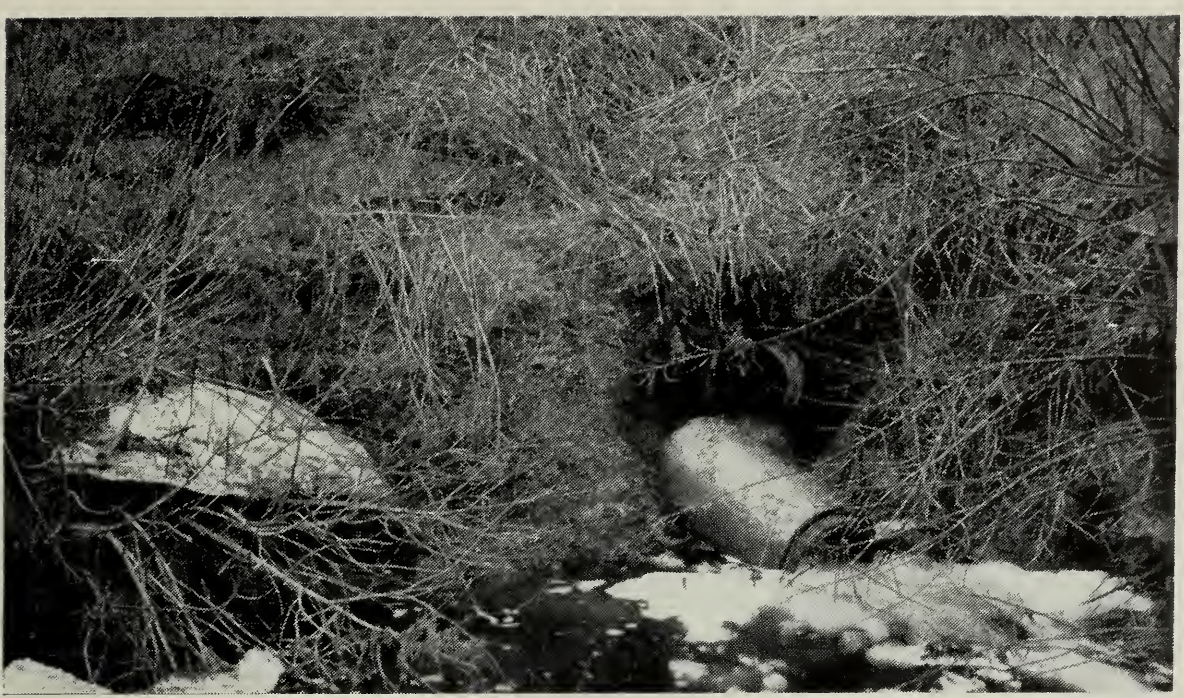


Fig. 23.—An outlet left in this condition soon becomes clogged and the whole tile system deteriorates.

SIZES

Sizes of tile for main drains should be worked out carefully after the area to be drained and the grade of the tile have been considered. Table No. 1 makes a good guide in this connection.

Lateral drains should be no less than four inches in diameter, especially so if the area is flat. Four-inch tile will carry almost twice as much water as three-inch tile. The cost of installation is no more. Much longer service will be assured. It is false economy to use tile too small to carry the water.

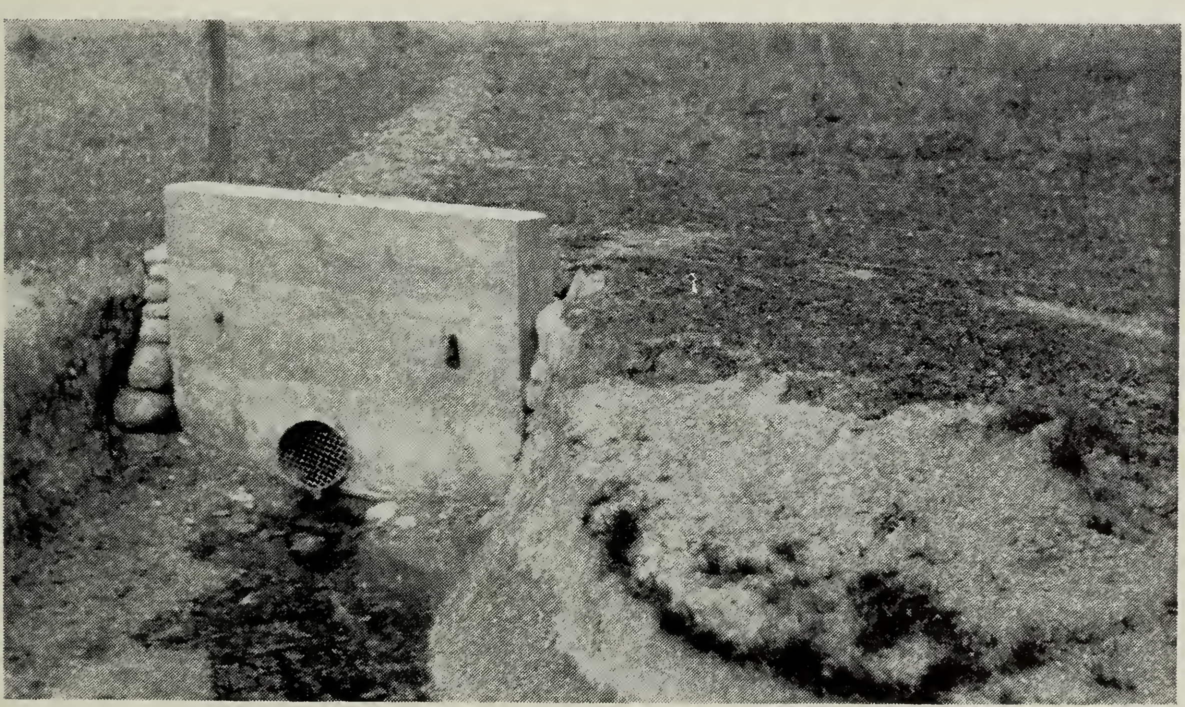


Fig. 24.—A well protected outlet—the concrete wall prevents caving, the screen prevents the entrance of animals, and the cement floor prevents undermining of the wall.

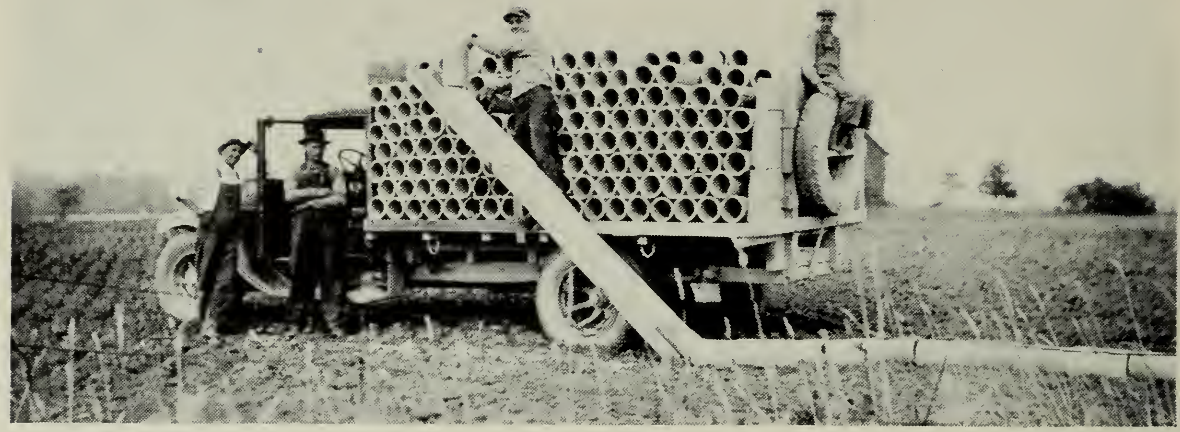


Fig. 25.—Delivering tile by truck insures a constant supply, fewer delays, less breakage and less handling. Frequently, they can be spread in the field along the trench lines.

OPEN DITCHES

Open ditches have an important place in many drainage projects. They provide the simplest means of ridding land of excess water. They may be of any size from that of a plow furrow to large dredge cuts which require engineering skill to plan and expensive machinery to construct.

Open ditches may be considered as falling into two classes:

1. Those required for the individual farm or small areas; i.e. the simple plow furrow, the grass waterway, or the small open ditch.

2. Those whose construction and maintenance are the concern of a number of farmers, and frequently involve roads and sometimes industrial sites.

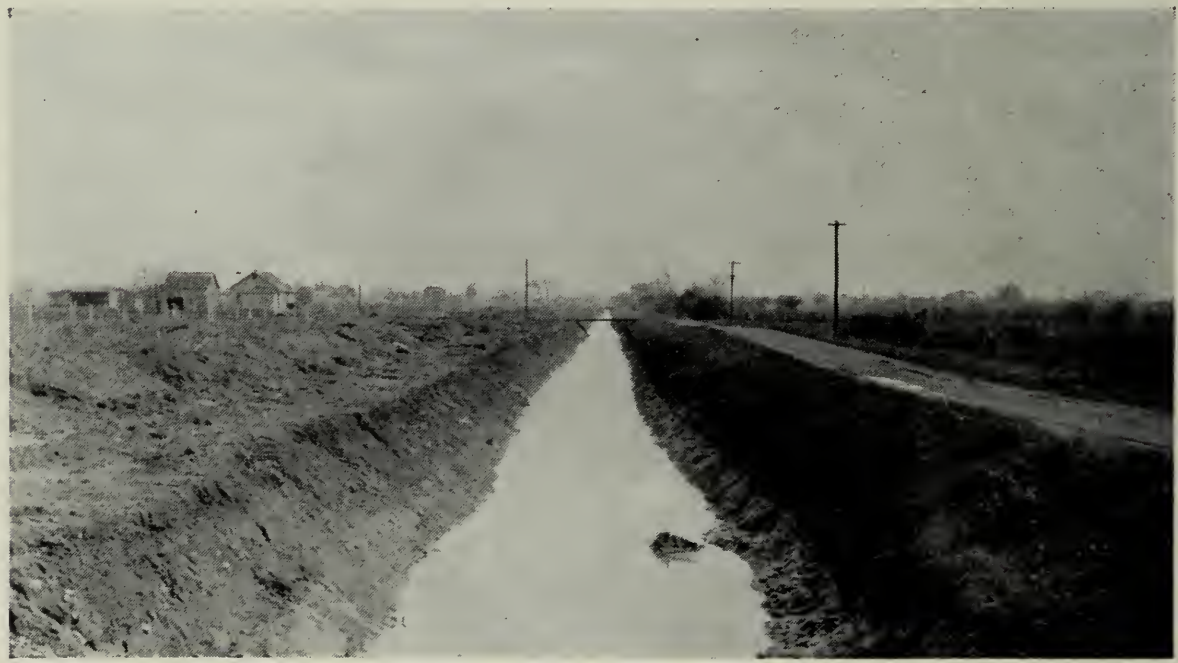


Fig. 26.—A Well Constructed Open Ditch.

Ditches of the first type are usually small and fairly inexpensive to make; those of the second type may reach the size of virtual canals and the cost of construction may be a matter of thousands of dollars.

ADVANTAGES OF OPEN DITCHES

Open ditches may be recommended under the following conditions:

1. Where there is a large flow of water.

It is necessary, at times, to decide between the advantages of using a large tile in preference to an open ditch. If it is necessary to use larger than a 12-inch tile, it might be better to use an open ditch, since large tile are costly. If, however, the drain is to serve a number of land owners where the cost may be divided, the use of much larger tile may be justified.

2. Where areas are subject to periodical overflow.

Some areas are so located that in the spring of the year, or at other times after heavy rains, water floods them from higher levels. In many instances, the soils in these areas being of a porous nature are well drained naturally. Open drains offer the most effective and economical method of controlling such flood waters. However, in the construction of open ditches to control such conditions, due regard must be given to preventing damage from erosion.

3. When the water table is near the surface.

When good outlets are not available for underdrainage—that is, where the area requiring drainage is so close to the permanent water table that the outlets cannot be kept clear, tile can not be recommended. However, recourse to pumping, until the outlet levels can be improved by deepening existing ditches or by removing obstructing rock ledges, is an alterative to the use of open ditches.

4. Where heavy clay soils are almost impermeable.

Some heavy clays do not permit rapid percolation of water. This condition can be gradually overcome by sub-soiling and by careful methods of cultivation and cropping. Until these practices have brought about an increased permeability in the soil, open ditches will prove effective. Tiling may help then, but because of the texture of the soil, the tile lines should be placed at relatively close intervals and the tile laid at relatively shallow depths.

5. Where excess run-off indicates the need for intercepting ditches.

Frequently, it is the surface water from bush land or seepage from springy areas that damages crops in adjoining areas or that interferes with cultivation. A ditch placed along the upper edge of the cultivated area may bring relief by diverting the excess water to an effective outlet.

DITCH LOCATION

No definite rules can be laid down for locating an open ditch. For this reason, a careful study of local conditions is necessary. Where practical, open ditches should follow the general course of the natural drainage. *Parsons recommends the following points be considered when digging open ditches:

1. The value to stream flow of straight courses and gradual curves.

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*Parsons J. L. S. "Land Drainage" Clark Book Co. 1915

2. The desirability of locating drains along property lines wherever possible.

3. The damage to farms through having ditches so located as to cut off small inaccessible corners or extending across them in angling or irregular directions.

4. The economy of traversing natural depressions.

5. The injurious effect of unstable soils upon ditch construction and maintenance.

GRADES

The grade of a ditch bottom is largely determined by the natural grade of the land where it is to be located. Grades may be increased slightly by giving the ditch a more direct course—that is, by removing sharp bends or curves. Where curves are unavoidable, they should be gradual. On the other hand, too heavy fall in a ditch may lead to excessive erosion, especially at the curves, while too little may cause silting; both conditions cause costly maintenance.

The appearance of the finished ditch depends, to some extent, on the equipment to be used and the conditions under which it is required to work. For instance, it is impossible to finish a ditch with proper side slopes with a floating dredge digging under water. On the other hand, a ditch can be more easily dug to specifications with drag lines, hoes, or other types of power shovels, especially where the ground is fairly solid.

The waste soil, if it is not to be spread, should be placed far enough from the edge of the ditch to prevent its washing back into the ditch or from its weight causing the banks to cave in during the spring thaw. The soil should not be placed so as to constitute a dam preventing surface water from getting into the ditch.

In most soils, ditch banks remain stable at a one-to-one slope. Sandy or decomposed muck soils require a one-and-one-half or two-to-one slope. It is a mistake to make ditches with steep sloping sides even in the more stable soils, since eventually undermining of the bank and consequent caving in are almost certain to occur.

GRASS WATERWAYS

Frequently, the grass waterway is the answer to the objectionable features of the more familiar type of open ditch. Instead of being narrow and deep, the grass waterway is relatively shallow but very much wider. Where conditions permit its use, it offers many advantages:

1. Its relatively wide, easy-sloping banks allow for a permanent grass surface.

2. This grass surface, together with the avoidance of steep banks, prevents almost completely all loss of valuable soil elements caused by the heavy erosion and caving in of ordinary ditch banks.

3. Working the land especially with modern machinery is made much less difficult, since the field instead of being broken up into irregular or inaccessible areas by impassably deep ditches requiring costly bridging,

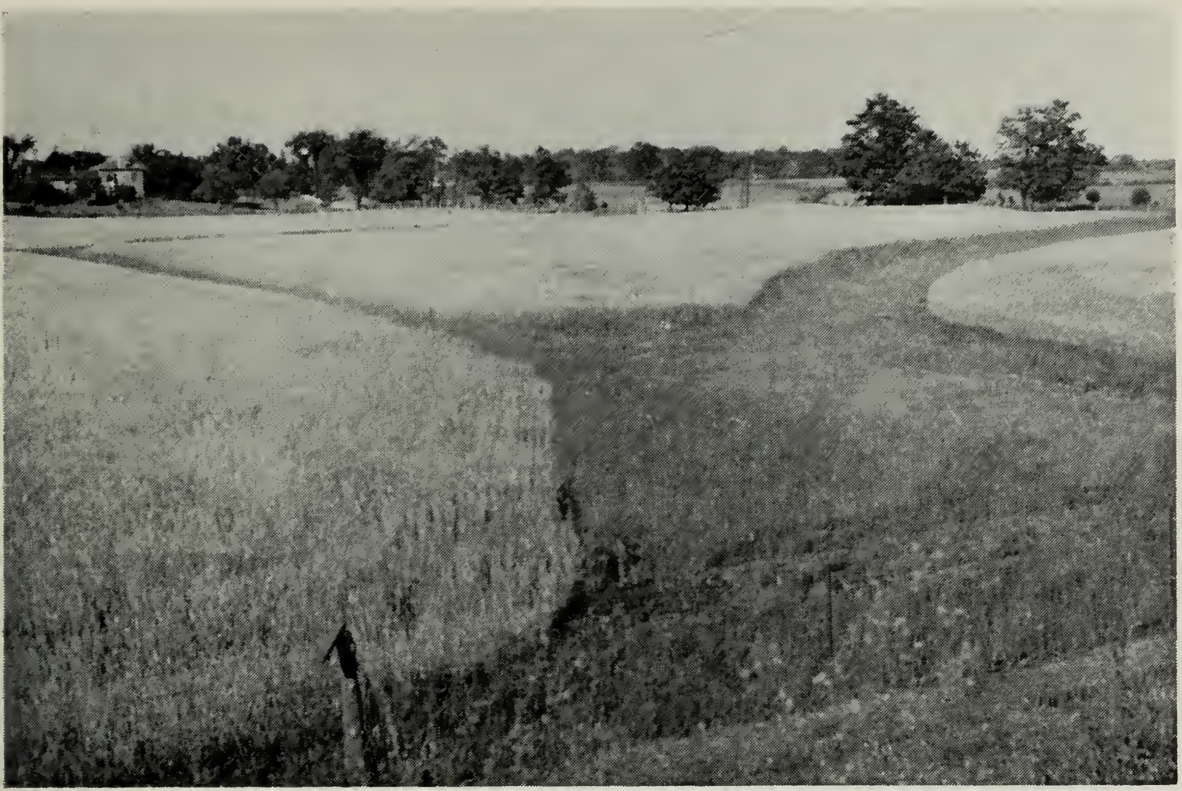


Fig. 27.—The Grass Waterway.

may be traversed wherever the operator wishes during all but the wettest periods.

4. There is no loss of arable land, since the immediate ditch area is producing grass for either hay or pasture instead of being completely waste land or, worse than that, a seed bed for noxious weeds.

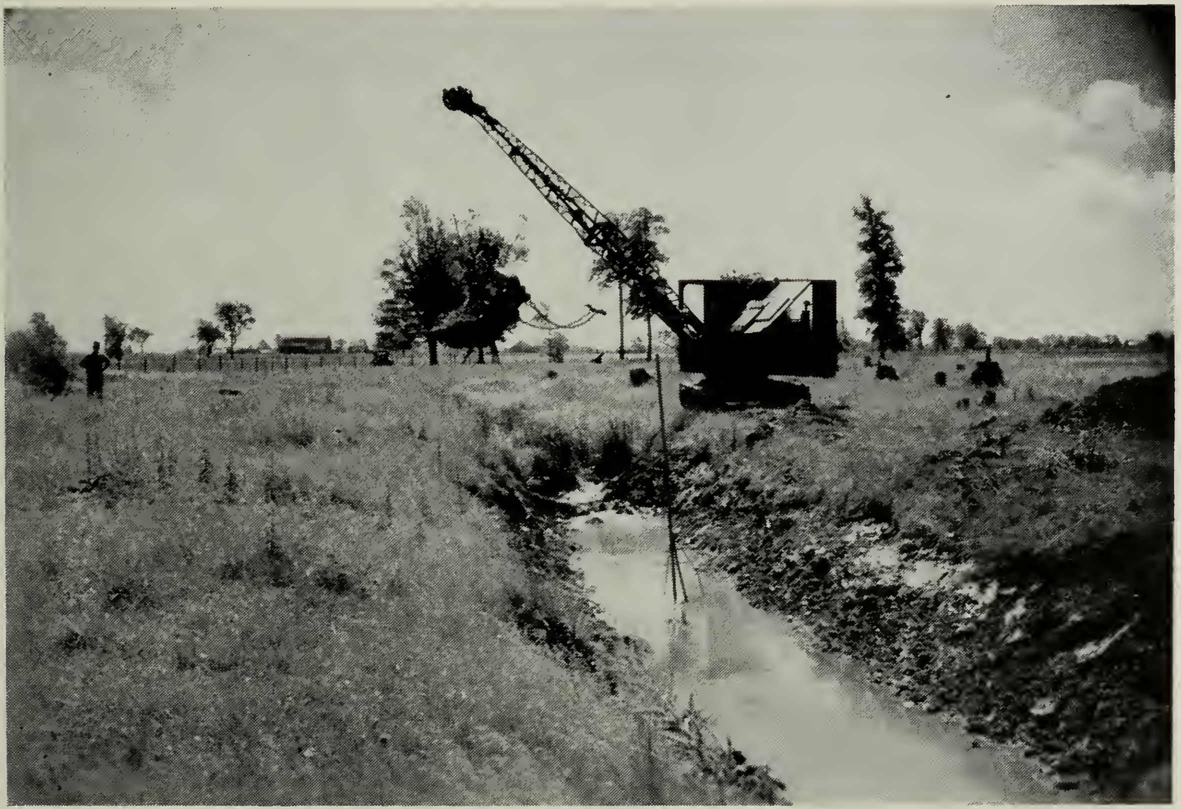


Fig. 28.—Dragline Used to Clean Out an Open Ditch.

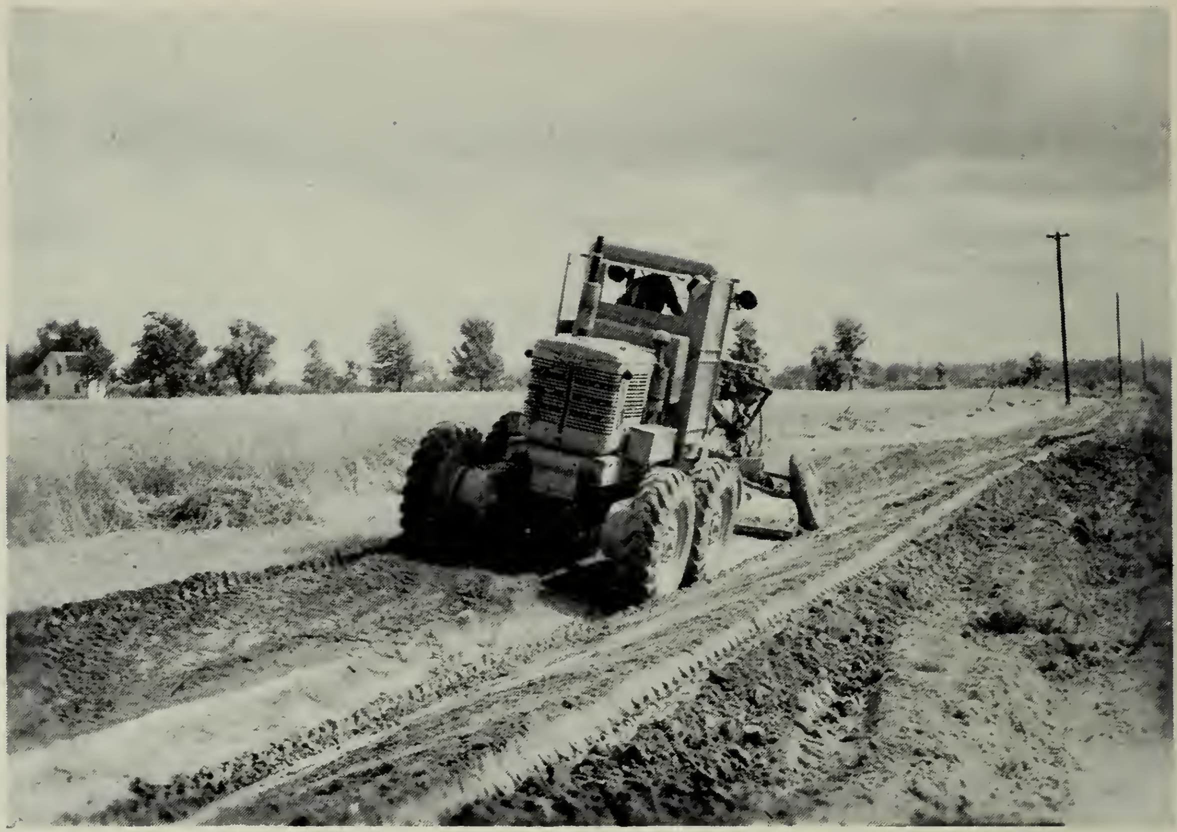


Fig. 29.—Power Grader is Most Effective in Constructing Shallow Ditches and Grass Waterways.

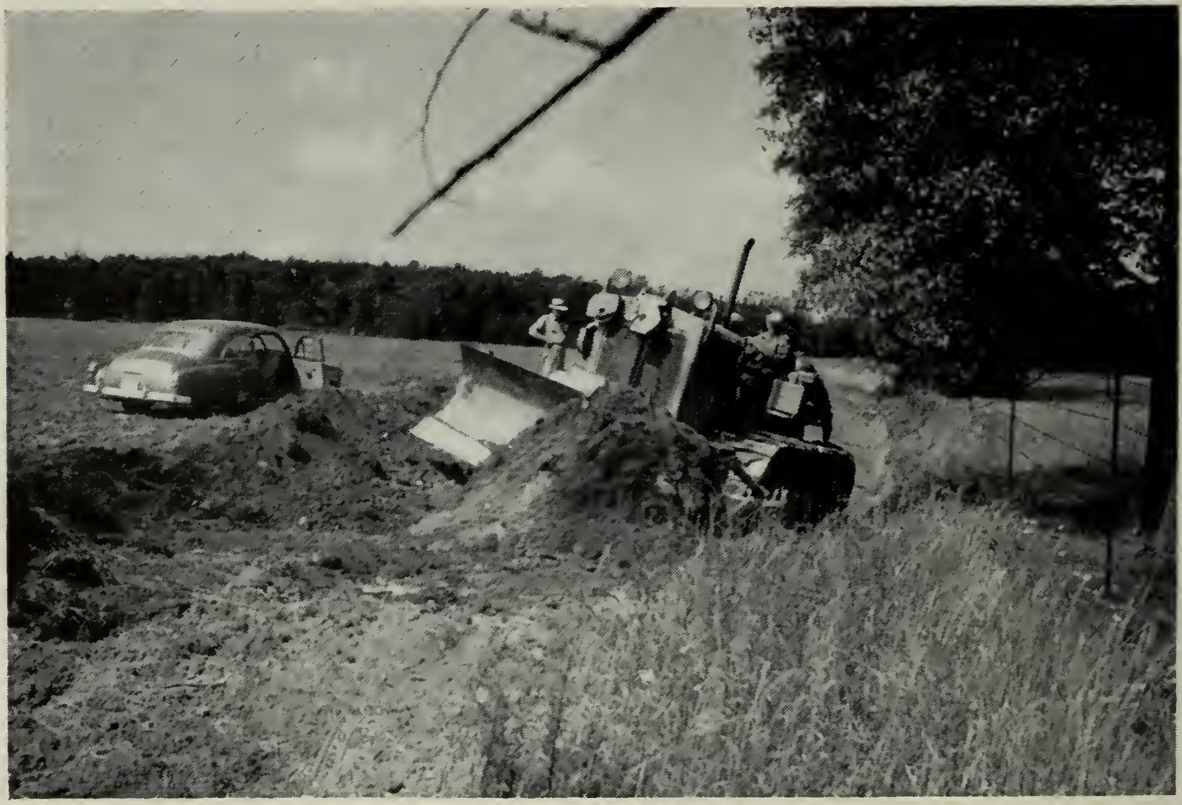


Fig. 30.—Digging Ditch with Bulldozer.

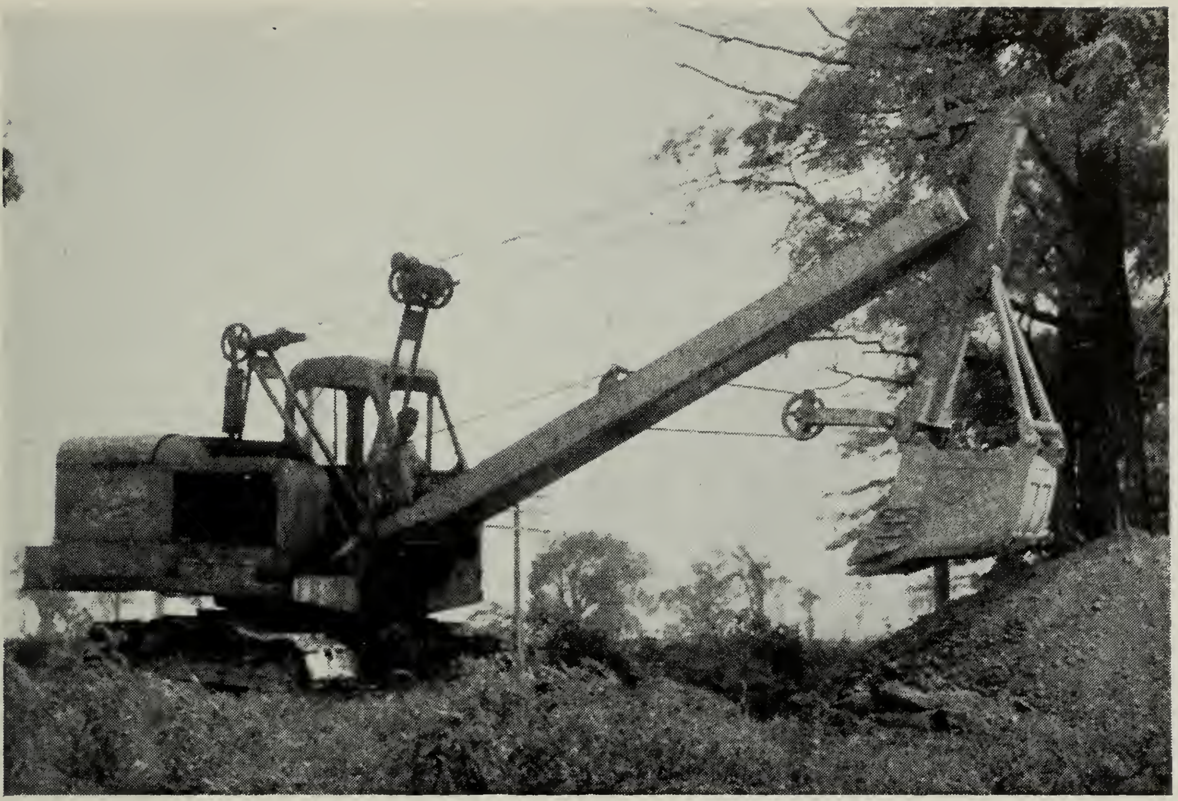


Fig. 31.—Backhoe Used in Ditch Construction.

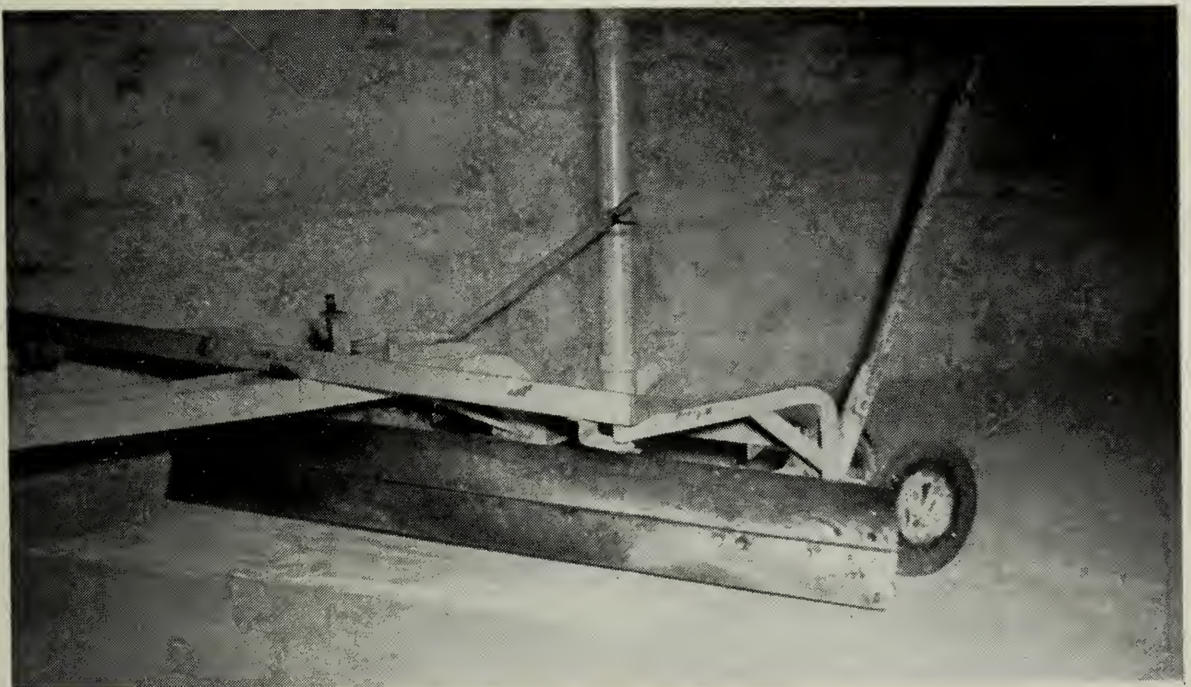


Fig. 32.—The Improved Little Hummer—A light grader drawn by a farm tractor for the construction of small open ditches.

METHODS OF CONSTRUCTION

1. Use of Power Machinery.

The old method that made use of teams and scrapers in digging ditches is being superseded by one employing power machinery. Some small jobs may be done with shovels attached to tractors, with Martin Graders, or with other light power machinery. Larger jobs require the use of road maintainters, bulldozers, or power shovels. Reclamation of marsh areas where footing for machinery is uncertain require floating dredges, which are power shovels mounted on scows. Where good footing exists, however, drag lines, hoes, and other forms of dredges are satisfactory.

2. Use of explosives.

For smaller jobs or when power machinery is not available, especially where extremely wet conditions make good footing for machinery impossible, dynamite may be used effectively.

Dynamite sticks are sunk at 18-inch intervals at the required depths along the line of the proposed ditch. One stick is then detonated either by means of a fuse or an electric spark. In order that the charge propagate effectively, the soil should be waterlogged. The effect of the explosion is to open the ditch almost instantly, and the waste soil is spread over a wide area. This method is adapted to dry soil conditions also, though here every charge must be wired and set off by the use of the electric detonator.

Though the method is a simple one, someone experienced in handling explosives should be responsible for the work.

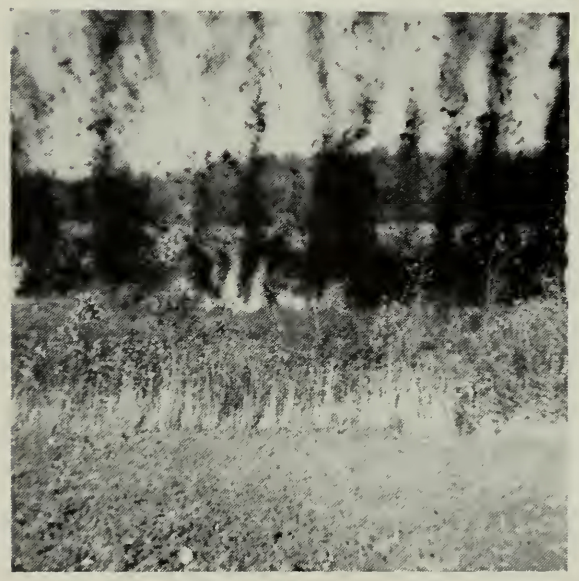


Fig. 33A.—Ditch Digging with Dynamite.

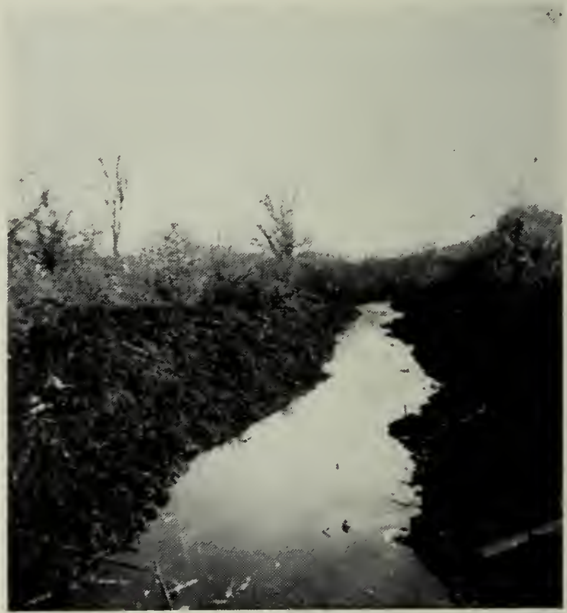


Fig. 33B.—The Completed Ditch.

OBJECTIONS TO OPEN DITCHES

1. They waste land.

The area actually occupied by the ditch and ground for some distance on either side is lost to tillage. The waste soil, if not spread, and the berm account for considerable lost acreage.

2. They are inconvenient and interfere with tillage operations.

The cost of building and maintaining a bridge to permit working a field corner cut off by a ditch may prove expensive. A field cut into irregular areas causes added difficulties in both cultivating and harvesting.

3. They promote the growth of weeds.

Most ditches are dry long enough during the summer to permit heavy infestation of weeds. Ditches then become the seed bed for the rest of the farm and for farms further down stream.

4. They are inefficient.

The real purpose of an open ditch is to obtain an outlet for excessive surface water and possibly for soil water. However, very little water finds its way from the sub-soil into an open ditch. The walls of the ditch become puddled, which checks the easy passage of water into it. Tile, on the contrary, bring about the formation of tiny channels in the soil, and good drainage is effected.

5. They are costly to maintain.

Open ditches, to be efficient, must be cleaned out every few years. Soon after they are dug, barriers begin to form. Sediment, trash, weeds, water-loving shrubs, and trees eventually form dams, and flooding occurs.

6. Manure and fine soil materials are lost as a result of surface washing.

When surface water is carried off in open ditches, fine soil particles and beneficial nutrients of manure are lost. Therefore, where erosion and the use of manure are to be considered, tile drainage is a definite advantage.

FINANCING OPEN DITCH WORK

Any ditch the construction of which concerns two or more farmers should be constructed under the terms of the Municipal Drainage Act. Proper distribution of construction and maintenance costs can then be established by the engineer in charge. Furthermore, the Township Council can relieve the individual land owners of one-third of the cost of the work through funds made available by the Provincial Aid to Drainage Act. Only two-thirds of the cost then falls on the individual owners. The Municipal Drainage Aid Act makes it possible for the Township to issue debentures to cover the cost of work. Those who benefit pay their portion through a special tax with the payments extended over a period of years.

TABLE 1. Size of Tile Pipe of Main Drain
(McConnell)

Fall in inches per 100 ft.		Acres Drained 3 in. Tile	4 in. Tile	6 in. Tile	8 in. Tile	10 in. Tile	12 in. Tile
60	inches	18.6	26.8	74.4	150.0	270.0	426.0
40	”	15.1	21.8	60.4	128.0	220.8	346.0
30	”	12.9	18.6	51.6	108.8	189.6	298.4
24	”	11.9	17.0	47.7	98.0	170.4	269.0
20	”	10.9	15.6	43.4	90.0	156.0	246.0
17 1–7	”	10.0	14.5	39.9	83.0	144.4	228.1
15	”	9.3	13.4	37.2	77.0	135.0	213.0
13 1–3	”	8.1	12.6	35.0	72.5	127.0	200.5
12	”	7.3	11.9	33.1	69.2	120.6	190.5
8	”	6.7	9.5	26.6	56.0	97.3	154.4
6	”	5.7	8.2	22.8	48.0	83.9	132.5
4 4–5	”	5.1	7.5	20.4	42.4	74.4	117.0
4	”	4.6	6.9	18.4	38.2	65.5	107.0
3	”	4.1	5.9	16.5	32.6	60.3	90.7
2 2–5	”	3.7	5.2	14.8	30.1	54.0	81.6
2	”	3.3	4.7	13.3	28.0	48.6	74.0
1 1–2	”	2.9	4.1	11.4	24.0	41.9	65.0
1 1–5	”	2.6	3.7	10.2	21.2	37.2	56.0
4–5	”	2.1	3.0	8.5	16.8	30.8	47.0
3–5	”	1.9	2.8	7.4	15.0	25.0	40.8

TABLE 2. Truck Loads

4″—1,000
5″— 650
6″— 500
7″— 400
8″— 250—300
10″— 160—175
12″— 120—130
Average Weight—2½ to 3 tons

TABLE 3. Approximate Weight of Tile of Various Sizes

Size of Tile	Weight of One Tile	Weight of 1,000 Tile
4 inches	6	6,000
5 ”	9	9,000
6 ”	11½	11,500
7 ”	15	15,000
8 ”	18½	18,500
10 ”	26	26,000
12 ”	34	34,000
14 ”	40	40,000
16 ”	47	47,000

TABLE 4. Number of Tile per Acre Required for Different Spacings

6 rds. or 100 feet apart	436 feet per acre
5.4 ” ” 90 ” ”	484 ” ” ”
4.7 ” ” 80 ” ”	544 ” ” ”
4.2 ” ” 70 ” ”	622 ” ” ”
3.6 ” ” 60 ” ”	726 ” ” ”
3.0 ” ” 50 ” ”	871 ” ” ”
2.4 ” ” 40 ” ”	1,089 ” ” ”
1.8 ” ” 30 ” ”	1,450 ” ” ”

TABLE 5. Cost of Excavating per Acre

Price per Rod	40¢	50¢	60¢	70¢	80¢
100 feet apart	$10.57	$13.21	$15.86	$18.51	$21.16
90 ” ”	11.73	14.67	17.60	20.53	23.46
80 ” ”	13.19	16.49	19.79	23.09	26.39
70 ” ”	15.00	18.85	22.62	26.39	30.16
60 ” ”	17.60	22.00	26.40	30.80	35.20
50 ” ”	21.12	26.40	31.70	37.00	42.30
40 ” ”	26.40	33.00	39.60	46.20	52.80
30 ” ”	35.15	43.97	52.72	61.52	70.32

FARM DRAIN TILE

Internal Diameter of Tile. Inches.	Minimum Supporting Strength Lb. per Linear Ft.	Maximum Average Absorption by Standard Boiling Test, per cent		
		Shale and Fire-Clay Tile	Clay Tile Surface-	Concrete Tile
4	800	11	14	12
5	800	11	14	12
6	800	11	14	12
8	800	11	14	12
10	800	11	14	12
12	800	11	14	12
15	1000	11	14	12

The above are the specifications for Farm Drain Tile required by the American Standard of Testing materials.

BULLETIN 502 JANUARY, 1955

TABLE TURNIPS
(RUTABAGAS)

ONTARIO AGRICULTURAL COLLEGE
GUELPH, ONTARIO

ONTARIO DEPARTMENT of AGRICULTURE
PARLIAMENT BUILDINGS *TORONTO, CANADA*

TABLE OF CONTENTS

Page

GROWING AND HANDLING TABLE TURNIPS - - - 3

WATER-CORE OR BROWN HEART OF TURNIPS AND CONTROL - - - - - - - - - - - - - - - - - - 5

2, 4-D INJURY - - - - - - - - - - - - - - - - - - 7

TURNIP ROTS AND THEIR CONTROL - - - - - - - 7

TURNIP INSECTS AND THEIR CONTROL - - - - - 10

THE STORAGE OF TURNIP ROOTS - - - - - - - - 14

ACKNOWLEDGMENT

Acknowledgment is tendered Mr. W. F. Strong, Supervising Inspector, Fruit and Vegetable Division, Canada Department of Agriculture, for his many helpful suggestions during the preparation of this bulletin.

TABLE TURNIPS

(RUTABAGAS)

GROWING AND HANDLING TABLE TURNIPS

J. LAUGHLAND,
Department of Field Husbandry, O.A.C.

The following suggestions are based on tests made at the Ontario Agricultural College and on practices followed by many successful growers in Western Ontario.

The Soil and Its Preparation

1. Use good, clean, fertile, medium loam soil. For disease and insect control it is safer to have turnips not more than once in 4 or 5 years in the same field.
2. Cultivate at two or three intervals before seeding to destroy weeds.
3. Under average conditions apply 10 to 12 tons of farm manure and 375 to 500 pounds per acre of 0-16-8, or 2-12-10, as indicated by soil test.
4. Have the soil well worked just before seeding.
5. If ridging is done make the ridges low; 2 to 3 inches high is ample. A ridger is now available to make these low ridges.

The Seed

1. Buy registered seed of purple top varieties. There is none better than Laurentian.
2. Properly graded and sized seed, which is available, has been used by some growers for the past few years with very satisfactory results.

Seed Treatment

Seed should be treated with a chemical seed dressing to prevent damping-off and ensure a good stand of seedlings. Most registered turnip seed is treated before packaging and the box will be marked to indicate this. Treatment with thiram (e.g. Arasan, C.I.L. Thiram, Naugatuck Thiram) will prevent damping-off. Treatment with a mercury-type seed dressing (e.g. Semesan) will prevent damping-off and reduce the amount of black rot in seedlings. Consult the section on turnip rots for directions on treating seed at home and for control of black rot and blackleg, if these are a problem.

Seeding

1. One-half pound of seed per acre is ample. Some growers who have used precision seeders sow as little as one-quarter pound of seed per acre and get a satisfactory stand of plants.
2. If your seeder will not sow this amount uniformly, roast half the seed. To do this, place the seed for roasting, about one inch deep, in flat pans and roast in the oven for about 2 to 3 hours at 300°F. A very hot oven might burst or char the seed. Place a few of the roasted seeds between wet paper for two days to be sure none can sprout. Mix the roasted

seed with the live seed, half and half, by pouring back and forth from one container to another. Sow the mixture at 1 lb. per acre.

OR The turnip seed may be sown through the fertilizer runs of a grain drill. Set the machine to sow 100 lbs. of fertilizer per acre. Leave every fourth spout open. Thoroughly mix one-half pound of seed with every 25 lbs. of fertilizer. If the drill cannot be set to sow this small amount, uniformly, use more fertilizer with the seed. This small amount of fertilizer is used only as a means to obtain uniform distribution of the seed and must not be considered as the fertilizer requirements. Do not mix the seed and fertilizer until just before seeding, otherwise injury to the seed may result.

OR Turnip seed can be mixed with chick grit of approximately the same size as the turnip seed. Mix at the rate of 14 cups of chick grit to 1 cup of turnip seed. Sow with the grain drill set on finest adjustment on wheat side.

TIME OF SEEDING

The main crop is usually sown during the last two weeks in June.

THINNING

Thin when the plants are 1½ to 3 inches high. Thin to 6 to 8 inches apart. It is necessary to use a hoe of not more than 6-inch cutting edge. Six to eight inch spacing will give the highest yield and smoothest turnips. This means 20 to 25 turnips to the rod of row.

CULTIVATION

Cultivate only for weed control and only to a depth of 1 to 2 inches. In other words merely "skim the surface". Avoid deep cultivation especially after the turnip roots begin to enlarge.

GRADING

All turnips are packed and sold under specified grade requirements.

Canada No. 1—2 to 4 in. across (limited market).

Canada No. 1—3½ to 5 in. across, Canada No. 1—4 to 6 in. across (most popular sizes).

Canada No. 1—5 in. and up, across (dehydration and soup only).

Turnips may be graded to any size within a grade to suit special markets.

Culls include those which are off shape, gouged, bruised or punctured, and also those containing growth cracks, worm injury, water-core, or any of the rot diseases such as Black Rot, Soft Rot, and Skin Rot.

HARVESTING

1. Some growers have developed harvesters which reduce the labour cost. Where the roots are pulled by hand, the trimming knife should be kept sharp.
2. Turnips are often trimmed too closely. Cut off the tail end of the root 1 to 1½ inches below the butt and rub off any small side roots with the back of the blade. Cut off the top with a single stroke leaving ¼ to ½ in. of neck, but do not cut into the body of the turnip.

HANDLING

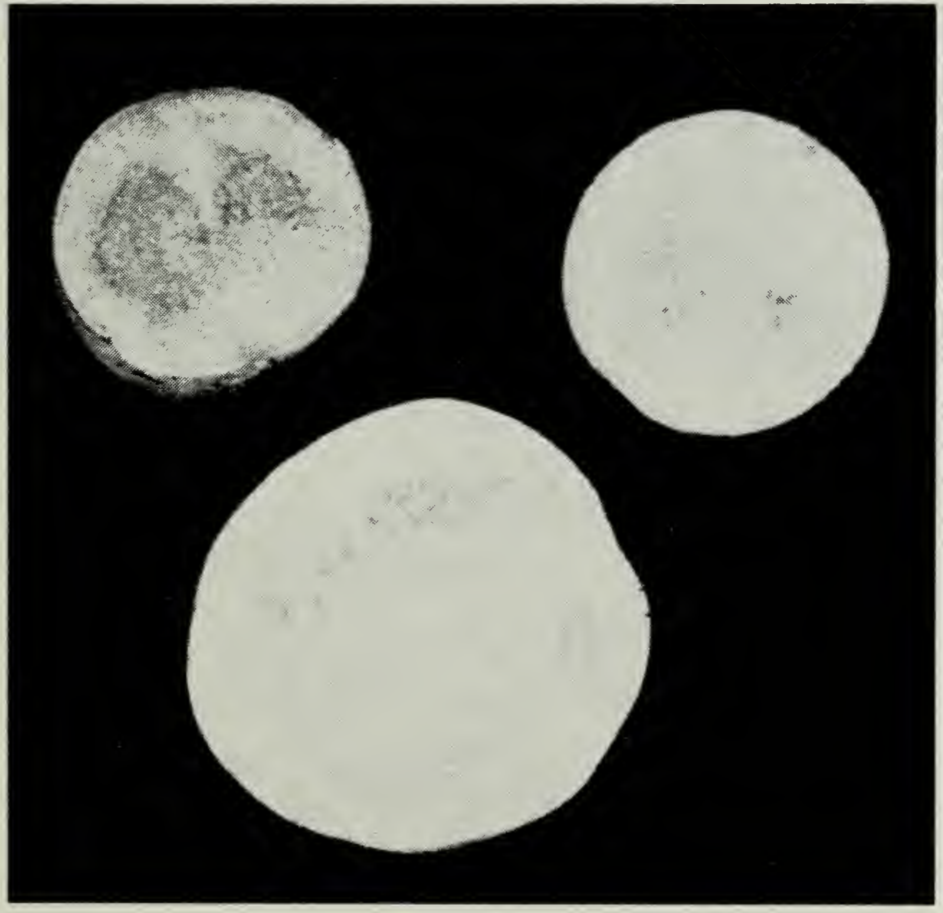
1. Once turnips are pulled, freezing or sunburning may make them culls.
2. The turnip fork should have knobs of sufficient size on the ends of the tines to prevent puncturing.
3. Bruising of turnips can be prevented by placing bransacks filled with straw under the chute for the first load, and against any sharp edges in the storage bin.
4. Never store culls along with shipping turnips.

WATER-CORE OR BROWN HEART OF TURNIPS AND CONTROL

C. B. KELLY,
Department of Botany, O.A.C.

DESCRIPTION

In the early stages of development the disease appears as water-soaked, but firm, patches in the turnip flesh. These areas may increase in size until almost the entire turnip is included. Severely diseased turnips may become brownish and punky inside, a condition more apt to be seen in storage than in the field in Western Ontario. It is practically impossible to detect slightly water-cored turnips without cutting them. Severely diseased turnips may be off shape and have a rough, corky to leathery skin.



Water-core.

CONTROL

This disease is caused by lack of available boron in the soil. Soil applications of borax before seeding have not been successful in many districts possibly because of the high lime content of the soil. **Water-core can be controlled by spraying or by dusting the leaves.** If soil applications of borax must be resorted to because of lack of spray or dust equipment, broadcast **granulated** borax **after** thinning rather than before seeding, at the rate of 20 to 30 lbs. per acre with a hand, cyclone grass seeder.

DIRECTIONS FOR SPRAYING

THE SPRAYER

A power sprayer, either wheel or motor driven, that will give at least 125 lbs. pressure is preferred. A good agitator in the tanks is necessary. Use 3 spray nozzles per row, the centre one directed down on the leaves and the two side nozzles set as low as possible and directed toward each other. With a 4-row, hand-pump barrel sprayer, use three nozzles per row as described above and spray only 2 rows at a time. Forty to sixty gallons of spray should be applied per acre, depending on the size of the leaves.

WHEN TO SPRAY

Thoroughly spray the leaves when the roots are 1 to 1½ inches across (about the thickness of one's thumb).

MATERIALS TO USE

Borax—Obtainable from fertilizer and spray companies but should be ground finer than table salt. Borax contains boron, the material necessary to prevent water-core.

Bentonite Clay—Obtainable from fungicidal spray companies. The Niagara Brand Spray Co., Burlington, Ont., has it in stock. This holds the borax on the leaves so it will not be washed off by rains.

Orthex (liquid form)—Obtainable from fungicidal spray companies. This material is used to make the spray spread evenly over the leaves and also to help make the spray stick to the leaves.

Seed dealers can obtain these supplies. The Niagara Brand Spray Co., Burlington, Ont., mixes the borax and bentonite clay ready to use.

MAKING UP THE SPRAY

If the borax and bentonite clay are not already mixed when purchased, thoroughly mix them while still dry in the proportions of 12 lbs. of borax to 3 lbs. of bentonite clay. Almost fill the spray tank with water. For each 40 gallons of water slowly add 15 lbs. of the borax-clay mixture while stirring rapidly. Then stir in 2 to 2½ cups of Orthex for each 40 gallons. Add enough water to fill the tank.

DIRECTIONS FOR DUSTING

THE DUSTER

Potato dusters, also a large pea duster, have been used with good success. An apron should be used to assist in getting as much dust as possible on the lower sides of the leaves. From the results so far it does not seem to make any difference as to the time of day the dust is applied. However, the dust outlets may clog if the leaves are very wet.

WHEN TO DUST

Similar to that described for spraying.

MATERIALS

The Bartlett Spray Works, Beamsville, Ont., the Niagara Brand Spray Co., Burlington, Ont., and Canadian Industries Ltd., Toronto, Ont., prepare the borax-dust mixture ready to use.

Apply 40 to 50 lbs. of the dust to each acre of turnips. If using a potato duster it may be necessary to suspend a weight on top of the dust to prevent arching of dust at the bottom of the hopper.

2,4-D INJURY

Turnips are sensitive to 2,4-D and related weed killers such as 2,4,5-T. Where roadsides are sprayed with chemical weed killers, it would be advisable to keep turnips well back from the road to avoid injury from wind-borne spray drift and injury by vapour from a roadside sprayed with a volatile ester form of 2,4-D.

Never use equipment for spraying turnips which has previously been used to apply any 2,4-D weed killer. It is impossible to wash the last traces of 2,4-D out of most spray outfits.

Turnips affected by 2,4-D may develop distorted leaves and abnormal roots. The amount of damage depends on the amount absorbed and on the stage of growth. There is no practical cure.

TURNIP ROTS AND THEIR CONTROL

C. B. KELLY, *Department of Botany, O.A.C.*
J. A. CARPENTER, *Department of Bacteriology, O.A.C.*

The following is a description of the important rots in turnips and the most effective known means of control.

BLACK ROT

Caused by *Xanthomonas campestris* (Pammel) Bergey *et al*

DESCRIPTION

The disease gets started in the field from using untreated seed and from diseased turnip or rape refuse remaining in the soil from previous years or brought to the field in manure. It may also start from neighbouring diseased fields. At first scattered diseased plants will occur throughout the field and are often unnoticed by the grower. From these diseased plants, however, the bacteria causing the disease are spread by wind, rain and insects to various parts of the field where they attack healthy plants. The disease is first seen on these plants as yellowish areas usually near the margin of the leaf; the veins in these areas are often blackened. The bacteria work down through the leaves, killing the leaf tissue as they go, and finally get into the root. There, they cause black streaks just under the rind or black areas throughout the flesh and render the turnip unfit for sale. The same bacteria will attack other closely related plants such as rape, cabbage and cauliflower.

SOFT ROT OR NECK ROT

Caused by *Erwinia carotovora* Jones

Description

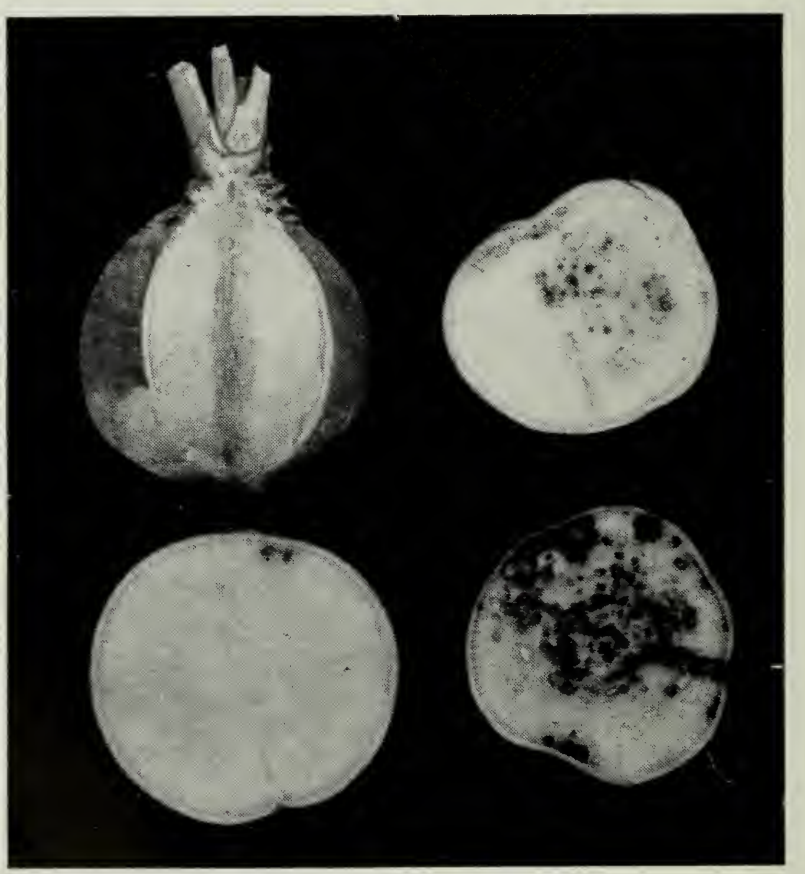
Evident in the field as sickly tops, or if one attempts to pull a turnip with an apparently healthy top the latter breaks away readily at the neck revealing a soft rotten mass. The flesh of the turnip may be partially or almost entirely decayed into a soft jelly-like mass with no distinct odour at first but later becoming putrid. The disease may start in the field and increase during storage. It is caused by a different bacterium from the one which causes Black Rot. It should not be confused with water-core.

BLACKLEG, SKIN ROT, OR PHOMA ROT

Caused by *Phoma lingam* (Tode ex. Fr.) Desm.

Description

Blackleg or skin rot is primarily a storage trouble. This disease begins in the field where it may sometimes be seen as a dry rot around the neck, but more often it is not detected until after the turnips have been stored for some time. In storage the disease appears on the skin as

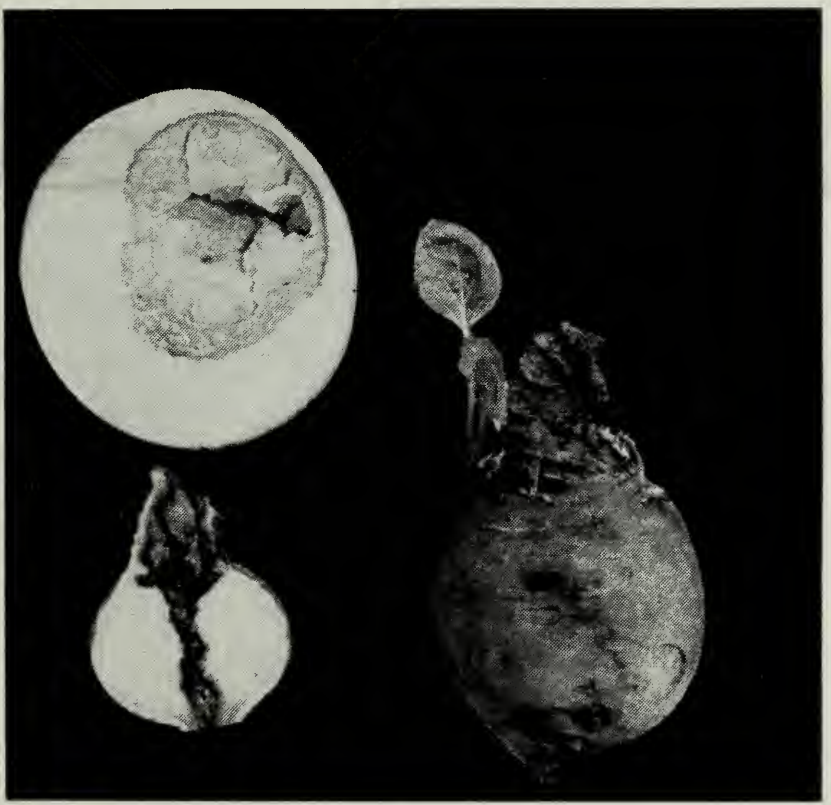


Black rot (upper left) rind removed from one side of a turnip to show characteristic black streaks. (Other three) cut turnips showing various amounts of disease.

scattered, dry, sunken spots bordered by dark areas. If diseased turnips are waxed, they will rot rapidly. The bacteria causing soft rot often attack turnips with blackleg. The fungus causing blackleg lives over for one or more seasons in infected plant remains or within the coats of infected seed.

CONTROL OF TURNIP ROTS

1. Practise as long a rotation as possible, so that the bacteria and fungi in the soil that cause turnip rots may have time to die out. A four-year rotation is satisfactory if rape, cabbage and cauliflower are not included. In a field where soft rot has been present do not grow, for at least four years, truck or vegetable crops such as mangels, carrots, cabbage, cauliflower, beets, onions, rape and lettuce. Even potatoes may be affected.
2. Avoid putting manure containing turnip refuse on a field where turnips are to be grown. It is also advisable not to use manure from stock fed on diseased turnips.
3. Do not cultivate when the plants are wet. The bacteria from infected plants are easily spread throughout the field by this means.
4. Never put turnips affected by soft rot in storage because it will spread rapidly to other turnips. Keep the storage temperature as close to 32°F. as possible and have sufficient air circulation to prevent sweating.
5. Hot water seed treatment is important for preventing black rot and blackleg when the disease is spread from infected seed; this is not likely to be the case when registered seed is sown. Ordinarily the



Soft Rot (lower right) diseased turnips from which the top has fallen away because the neck was rotten. (Other two) cut turnips to show soft jelly-like rot.

presence of these diseases can be blamed on the remains of diseased plants left in the soil from a previous crop of turnips or related plants such as rape, cabbage or cauliflower.

The Treatment

Place the seed to be treated in a cheesecloth bag of ample size. Immerse the bag of seed in hot water maintained at 122°F. for 15 minutes. Use an accurate thermometer. Rinse in cold water immediately and spread out to dry. Test for germination, especially of weak or old seed. To protect hot-water-treated seed from damping-off, it should be further treated with a seed protectant such as Semesan or a thiram (Arasan, C.I.L. Thiram, Naugatuck Thiram). This can easily be done at home. Place the seed in a container with a tight-fitting lid (e.g. a gallon vinegar jug or a two-quart fruit jar), add the proper amount of seed protectant dust (see manufacturer's directions), and shake thoroughly until the dust is uniformly distributed over the seed. The container should not be more than half full to ensure thorough mixing. Avoid breathing the chemical dust.

TURNIP INSECTS AND THEIR CONTROL

H. W. GOBLE and J. G. OUGHTON,
Department of Entomology, O.A.C.

The insect pests of Ontario turnips, in order of importance, are root maggots, aphids (lice), flea beetles, and leaf-eating caterpillars. All of these pests may vary in importance from year to year and from place to place. The grower should carefully watch his crop and seek the advice of his agricultural representative if he finds any pest that is rapidly increasing in numbers.

ROOT MAGGOTS

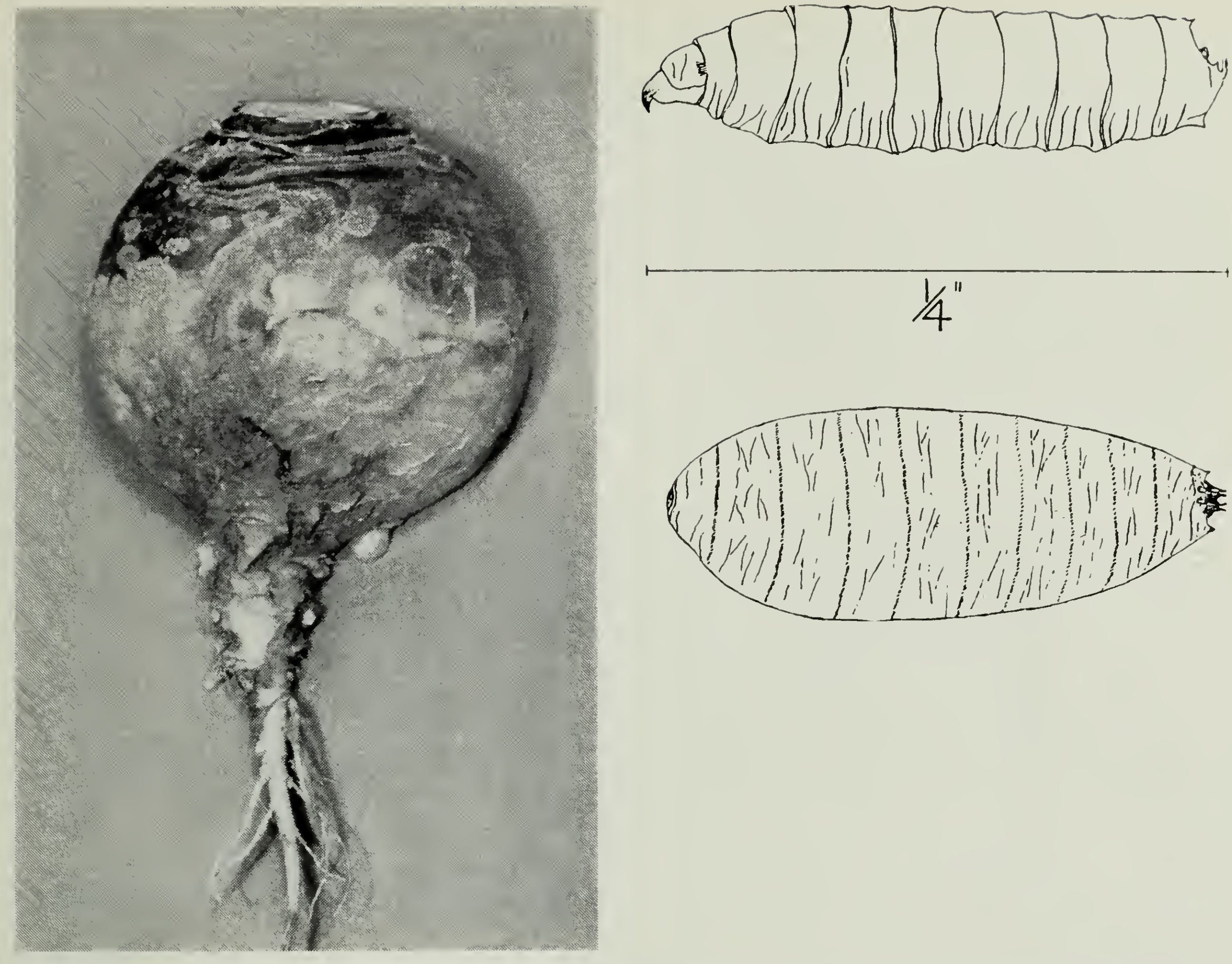
Hylemya brassicae (Bouché), the cabbage maggot, is the important species. Two species of seed-corn maggots *(Hylemya spp.)* are apparently secondary invaders of turnip roots. The cabbage root maggot is a white legless "grub" that is ¼-inch long when full grown. It infests the roots of various plants of the mustard family—cauliflower, cabbage, radish, and turnip. It eats and burrows through the root, thereby weakening the plant. In addition, its unsightly burrows reduce the market value of the root.

The adult is a two-winged fly, somewhat smaller than a housefly. The egg, a slender white object 1/25-inch long, is found near the base of the plant and at or near the soil surface. The maggot when full grown leaves the root and changes into the resting stage (puparium)—a brown, oval-shaped object ¼-inch long. In this stage the pest spends the winter in the soil.

CONTROL

Various new insecticides are coming into use. These have not yet been tested enough under Ontario conditions to permit a firm recommendation. The measures suggested below are on a trial basis. Information from growers on the success or failure of these suggestions would be welcomed.

Before planting—band treatment: Five pounds of actual heptachlor or actual aldrin per acre should be applied as a spray, wettable powder, or dust in a 12- to 15-inch band, and then lightly worked into the top inch or



Left: maggot burrows in a turnip. Right upper: a mature root maggot (larva). Lower: the resting stage (puparium) found in the soil.

two of soil. Plant seed down the centre of the band. The advantage of this method is that it concentrates the insecticide where it is needed and hence is cheaper. The disadvantage is that it may be difficult in practice to sow seed accurately in such a narrow band.

Before planting—with fertilizer. Some growers claim success with this method. Try a rate of five pounds actual aldrin or heptachlor per acre.

NOTE: 1 pound actual heptachlor = 40 pounds of 2½% dust or ½ gallon emulsible 2E or 4 pounds 25% wettable powder.

1 pound actual aldrin = 20 pounds of 5% dust or ½ gallon aldrin "20" or 4 pounds 25% wettable powder.

Damage by the root maggot may be reduced by attention to the following points:

1. *Last year's turnip field.* Turnips should not be allowed to grow up and flower in last year's field. They may support an early brood of root maggots, which may mature in time to infest the later crop. The field should be deeply ploughed and thoroughly worked, as early as possible. This will kill some of the wintering stage of the pest.

2. *This year's turnip field.* Choose a field which is as far away as possible from all turnip fields (your own and your neighbours') of the previous year. Some growers believe that manure and rotting sod attract the pest. To be on the safe side, plough under the manure or sod in the fall, and then in the spring work well with the disc.

   Keep the fence rows clear of weeds.

3. *Root cellars.* These may help to carry over the hibernating stage. As soon as the cellar is empty, carefully clean the floor and destroy the refuse, preferably by burning.

STRIPED FLEA BEETLE

Phyllotreta villata (F.)

The adults are small black beetles, 1/12-inch long with a wavy, inconspicuous yellow stripe down each wing cover. They hop like fleas when disturbed. They attack the seedling plants and eat holes in the leaves and stems. They may kill the young seedlings.

CONTROL

If many shot-like holes are noticed in the leaves, dust with 3% DDT or use a spray of 2 lb. of 50% DDT wettable powder in 100 gallons of water.*

APHIDS (PLANT LICE) ON TURNIPS

The two species of aphids that commonly attack turnips are the cabbage aphid, *Brevicoryne brassicae* (L.) and the turnip aphid, *Rhopalosiphum pseudobrassicae* (Davis). The cabbage aphid is grey while the turnip aphid is green. Both the young and adults of these pests suck the juice from the leaves, causing them to curl and become a sickly yellow or purple colour. Growers should watch for these pests and should examine curled leaves in particular. If they are found on the small leaves in the crown of the plants, it is more likely that they will cause severe damage unless controlled. Occasionally a whole field will be destroyed by aphids. When this happens late in the season, rot develops following the attack and the turnips give off a strong odour of decay. Severe attacks may occur in cycles. The crop was very severely damaged in 1949.

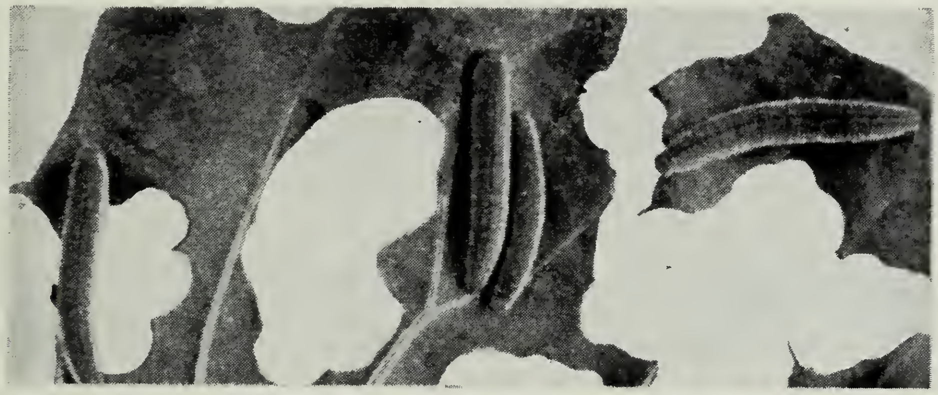
CONTROL

Control by spraying or dusting with some of the newer organic phosphate insecticides is now possible. While there has been only limited experience with control on a field basis and on large plants, recommendations can be made. Sprays and dusts are most effective when the weather is hot. More insecticide will be required per acre when the turnips are large, as in August and September.

1. **Malathion**—This material is available as 25% wettable powder and as a 4% dust. An emulsion form may be available in some areas. While this organic phosphate material should not be used carelessly, it is not as dangerous to handle as parathion or TEPP. Use at the rate of 2 pounds of 25% wettable powder in 100 gallons of water*. Apply this amount to 1 acre, or use 30 to 40 pounds of 4% dust to the acre.

2. **TEPP**—This material is available as a 20% or 40% liquid. A 1% dust, if freshly made, is also effective, but is available only on special order. TEPP is a fairly effective material for aphids on turnips when used at the rate of ½ pint of 20% TEPP liquid (¼ pint of 40%) to 100 gallons of water*. Apply this amount to 1 acre.
3. **Parathion**—Use at the rate of 1 to 2 lb. of 15% parathion wettable powder to 100 gallons of water*. The greater amount is required on large plants. Apply this amount to 1 acre.

Caution: Parathion and TEPP are deadly poisons. For the safe handling of these products carefully follow all warnings and directions which are found in every carton and on every container. Masks must be worn. Follow manufacturer's directions concerning the use of malathion.



Imported cabbage worms, natural size (after Britton).

Zebra caterpillar and adult.

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*—For best results with sprays, apply 100 gallons to the acre. If your sprayer will not deliver this amount per acre, but instead will deliver only 50 gallons, be sure that the per acre rate of malathion, TEPP, or parathion is maintained by adding the correct amount to 50 gallons. If the amount your sprayer applies is not known, calibrate the machine before using. Guides for sprayer calibration are available on request. Attempt to cover the undersides of the leaves as much as possible. Since leaves will be difficult to cover on both sides, repeat applications may be necessary.

LEAF-EATING CATERPILLARS

There are four species of caterpillars commonly found feeding on the leaves of turnips. The cabbageworm is green in colour. The zebra caterpillar is dark with longitudinal stripes and small wavy transverse bands. The cabbage looper is one of the measuring worms. The caterpillar of the diamond-black moth, the fourth species, is usually not as common on turnips in Ontario.

CONTROL

Most years it is not necessary to apply control. If caterpillars are present in numbers that may defoliate the plants, dust with 3% DDT or spray with 2 lb. of 50% DDT wettable powder in 100 gallons of water.

STORING TABLE TURNIPS

E. W. FRANKLIN,
Department of Horticulture, O.A.C.

Losses in stored turnips are often serious. In many instances the loss is due to either a poor storage structure or mismanagement of the storage.

It is unfortunate that the impression is prevalent that the turnip can survive considerable mistreatment. Actually they must have carefully controlled conditions to remain in good condition during several months of storage.

Many existing storages could be greatly improved with relatively little expense. Information concerning this may be obtained from the Ontario Department of Agriculture Circular No. 155, "Modernizing the Turnip Storage".

Some of the important points in the management of a turnip storage are as follows:

1. Each year before the crop is stored clean out the storage thoroughly. Spray all surfaces with a mixture of 2 lb. copper sulphate and 4 lb. hydrated lime in 10 gal. of water.

2. Store only sound roots of sizes suitable for the trade.

3. Turnips store best and longest at 32°F. Regulate the ventilation of the storage so as to maintain this temperature as closely as possible.

4. Turnips require very high humidity (above 90%) in the storage air at all times or shrivelling will occur. Earthen floors help to keep the humidity high. Also, water can be put on the floor to increase the humidity provided the turnips are up off the floor in bins.

TO STOP SPROUTING

Maleic Hydrazide, a synthetic hormone, has the ability to stop sprouting in stored turnips. The chemical is dissolved in water and sprayed on the growing turnips 3 to 4 weeks before harvest. Complete information on the use of this chemical on turnips may be obtained from the Department of Horticulture, Ontario Agricultural College, Guelph.

BULLETIN 503 MAY 1954

THE RAISING OF
GUINEA PIGS, HAMSTERS RATS AND MICE

●

A. H. KENNEDY
ONTARIO VETERINARY COLLEGE
GUELPH, ONTARIO

ONTARIO DEPARTMENT of AGRICULTURE
PARLIAMENT BUILDINGS • TORONTO, CANADA

Contents

GUINEA PIGS

Selection of Stock - - - - - - - - - - - - 5
Housing - - - - - - - - - - - - - - 5
Feeds and Feeding - - - - - - - - - - - - 6
Breeding - - - - - - - - - - - - - - 6
Diseases - - - - - - - - - - - - - - 7

HAMSTERS

Characteristics - - - - - - - - - - - - - 9
Housing - - - - - - - - - - - - - - 9
Feeds and Feeding - - - - - - - - - - - - 10
Breeding - - - - - - - - - - - - - - 10
Diseases - - - - - - - - - - - - - - 10

RATS AND MICE

Housing - - - - - - - - - - - - - - 11
Feeds and Feeding - - - - - - - - - - - - 13
Breeding - - - - - - - - - - - - - - 13
Diseases - - - - - - - - - - - - - - 13

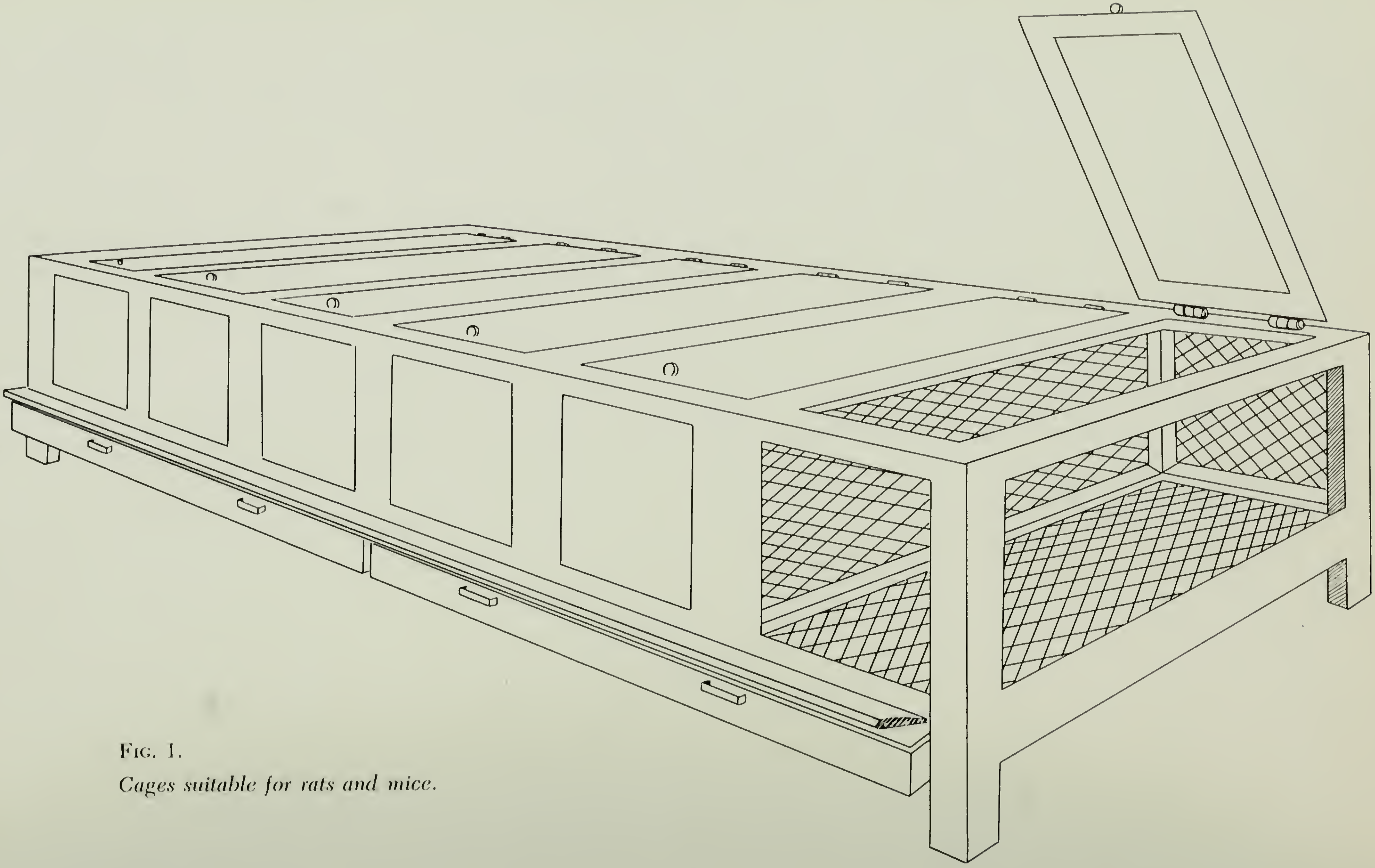

FIG. 1.
Cages suitable for rats and mice.

THE RAISING OF GUINEA PIGS, HAMSTERS, RATS AND MICE

A. H. Kennedy
Ontario Veterinary College
Guelph, Canada

Guinea pigs, hamsters, rats and mice are raised as pets or fancy stock, or for scientific work. When used for this latter purpose they must conform closely to specific requirements of type, or strain, age, size, weight, length of hair, colour of skin, etc. Care, skill and familiarity with laboratory requirements are necessary in order that the institutions desiring these animals can be assured a reliable supply of suitable stock.

GUINEA PIGS

Selection of Stock

There are four varieties of the domestic guinea pig. The English variety, which is the oldest and most popular for all purposes except show, is the type used most frequently in scientific work. It is a smooth, short-haired animal and specimens of various colours are to be found — pure white, red, grey, brown or glossy black. However, it seems impossible to produce a pure strain of self-coloured stock except in the case of the white guinea pig. The majority are spotted; common colours are fawn, light grey, reddish-brown, dark brown and cream, interspersed with white or black. The pigment of the hair is repeated in the underlying skin, which is white only under white or cream-coloured areas of fur.

The Peruvian guinea pig is raised for exhibition purposes or for pets. The most desirable characteristic of the breed is the silky texture of the long hair, which spreads over the head and face as thickly as it does over all other parts of the body.

The Angora guinea pig, also known as the Peruvian Silky, is a combination of the Peruvian and English varieties. The head and face are covered with the smooth, short hair of the English type, while the body has the long hair of the Peruvian. This type of guinea pig is not raised to any extent at the present time.

The Abyssinian or Rosette variety has a ruffled coat of a rough, wiry texture. The body and head are covered with "rosettes" or circular bunches of hair. The more rosettes, the better the quality of the specimen.

Strong, healthy animals which have matured quickly should be chosen for breeding stock. Full-grown guinea pigs should weigh almost 2 pounds when about 18 months of age. As a rule the female, except when pregnant, is lighter than the male of the same age.

Housing

Guinea pigs may be kept in open or covered courts in which they have room to exercise. Courts are divided into small runs, each of which has its own hutch or sleeping shelter. A run measuring 10 feet long and 6 feet wide accommodates from 30 to 60 guinea pigs. Less work is required in feeding the animals and cleaning the living quarters when courts are used.

Under conditions prevailing in Ontario, however, hutches are preferable to courts. A hutch measuring 20 inches wide, 3½ feet long and 18 inches high gives sufficient space for the accommodation of one male, three or four breeding females and their progeny until the latter are weaned.

The hutch should have a door which extends over almost the entire front of the structure. This door should be hinged at the side and made of fairly heavy, square-meshed wire netting. Ventilation is provided at the rear of the hutch by an opening covered with galvanized small-meshed wire netting, such as that used for poultry. If this netting is stretched on a frame, it can serve as a covering for both door and ventilator. Hutches should be raised at least 18 inches above the floor. Chaff, shavings or hay make satisfactory bedding material.

Living quarters should be kept free of infection by cleaning with hot water and soap and with a DDT and creolin solution. The structures should also be whitewashed with lime.

The common brown rat is one of the major enemies of the guinea pig. This rodent is attracted to the pens by the grain in the feed. It steals the food and also gnaws through the hutch walls and devours the young animals. Buildings to be used for housing guinea pigs should therefore be made rat-proof.

Feeds and Feeding

Succulent green food, such as spinach, Swiss chard, cabbage, lettuce, clover, alfalfa, green corn, kale, carrot tops and sprouted oats, and mixed grains or pellets are essential to the health of guinea pigs.

An ideal summer feeding is composed of a grain mixture of rolled oats and wheat bran, with 5 per cent alfalfa meal, and greens and carrots.

A diet suitable for winter feeding is as follows:

Fresh water	Daily.
Crushed oats (with the addition of ½ oz. cod liver oil to each quart of rolled oats)	Daily.
Alfalfa hay	Daily.
Mangels	Four times weekly.
Carrots	Twice weekly.
Cabbage, Swiss chard or spinach	Once weekly.

Guinea pigs should be fed at regular times, preferably twice a day. Each animal should be given only as much as it will eat, so that no food is left over until the next feeding time. The food should be varied by giving greens or roots in the morning and the grain mixture at night.

Water may be provided conveniently by using a medicine bottle fitted with a cork into which a bent glass tube is inserted. The bottle is inverted and hung in a holder attached to the wire netting on the side of the housing structure, so that the animal can lap from the end of the tube, obtaining only a drop of water at a time.

Breeding

Guinea pigs breed at a very early age. The females are usually mature when they are approximately 2 months old, depending on diet and strain. They have only two mammae. The period of gestation is about 67 days. The first litter is usually small and very often dies. Subsequent litters should average from three to five young.

Usually females get along well together and when two have young at about the same time, both nurse the progeny indiscriminately. Occasionally two females are antagonistic, in which case separation is desirable.

Young guinea pigs are well developed when born. They are fully furred and their eyes are open. They are soon able to run about freely, and within a day or two after birth begin to take food other than the mother's milk.

Hutches large enough to accommodate 50 or more young are desirable. Males of different sizes should be kept in separate cages; otherwise there may be fighting and the weaker animals may be injured.

The recommended breeding procedure for guinea pigs is summarized below:

1. Place one male with 12 females.
2. Change male weekly.
3. Remove pregnant females to individual cages or to small cages containing two or three other females.
4. Wean young when 6 to 8 weeks of age. When they are about 3 weeks old, the mother ceases to give them attention but it is wise to leave them in the hutch three or four weeks longer.
5. Place males and females in separate cages when weaned.
6. Retain white females for breeding stock when producing animals for laboratory use.
7. Distribute young females to breeding pens when the are 10 ounces in weight — i.e. when they are from 5 to 6 months old.
8. Use breeding females for one year only. If first bred when 3 months of age, guinea pigs have more or less completed their usefulness when they are 1½ years old.

Diseases

Guinea pigs are not susceptible to many diseases, and when illness occurs it is often closely related to the nature, quality and quantity of the food eaten. In general, judicious feeding, cleanliness of surroundings, pure water, abundant room, reasonably constant temperature and good ventilation help ensure against disease.

Colds and Pneumonia. — Sudden exposure to low temperatures, improper ventilation, wet cage floors and sweating due to overcrowding, combined with low resistance to certain organisms, result in colds and pneumonia.

Early symptoms include sneezing, watery eyes, dry nose followed by nasal discharge, and hair on the inner side of the front paws matted with mucus. Laboured breathing, with the sides of the animal showing a throbbing movement, indicates that the infection has reached the lungs. Pneumonia is fatal to guinea pigs in most cases. Post-mortem examination of an animal that has succumbed to this disease reveals severely congested lungs.

Paratyphoid Infection. — Guinea pigs afflicted with paratyphoid infection become thin and inactive. The excreta are usually very loose and bloody. In advanced cases, the animal leaves all food, huddles in a far corner of the cage and dies within a few hours.

Food and water contaminated with faecal material is the main source of infection. Food should be kept in tightly covered containers until required, and should be well protected against exposure to cats, wild mice, rats and flies. When the disease occurs, all positive carriers of infection should be destroyed at once. Cages and pens should be thoroughly disinfected. In disinfecting metal structures, the use of live steam or a blow-torch is recommended. Wooden structures should be steamed and painted with coal-tar dip (such as creolin) and then may be dried with a blow-torch if operated out-of-doors away from fire hazards.

Tuberculosis. — Guinea pigs infected with this disease slowly waste away, lingering for two or three weeks. A dry cough may be present. Since the disease in this species is incurable, the tubercular animals should be destroyed.

Vitamin C Deficiency. — The guinea pig breeder must always be on the watch for signs of vitamin C deficiency in his animals. Many guinea pigs suffer from a partial deficiency of this nature and show the milder symptoms, especially during the winter. The first noticeable symptom is loss of weight in spite of a good supply of hay and mash. The young animals stop growing and have a pecular "pinched" look. Pregnant females abort. The addition of more greens and roots to the diet may arrest the disease at this stage, but the animal does not regain good health. In advanced cases the animal becomes lame because of swollen and tender joints and is easily hurt when handled. The gums swell and bleed easily and the teeth become loose. The odour from the mouth is offensive. If green food is offered, the animal hurries to it in spite of painful joints, but loses interest after a half-hearted attempt at eating. As a rule the adults do not die from this deficiency, but death is not uncommon among the younger animals.

To guard against vitamin C deficiency, the breeder must ensure that his animals receive the proper food. Beets, carrots and mangels are poor sources of this vitamin. Swedes have a high content and should be shredded rather coarsely so that the animals will eat them. The addition of shredded apple and beets to the swedes will induce the animals to consume larger portions. Parsnips also are rich in vitamin C.

Indigestion. — Indigestion and diarrhoea may result if a guinea pig is given too much damp green food such as alfalfa, clover, cabbages and grass. In young animals indigestion may also be caused by lack of exercise.

Indigestion is indicated by slobbering due to excretion from the stomach, so that the animal becomes wet under the lower jaw. "Pot belly" is another symptom; the stomach enlarges until it is almost double its normal size.

When such abnormalities occur, the diet should be carefully checked and more dry hay provided. Castor oil and intestinal antiseptics should be administered.

Premature Birth. — Premature birth is caused by jarring, dropping or unnecessary handling of the female when she is about to have young. Such an occurance may also result from a continued disturbance in the pen, such as males fighting. Breeding stock should be kept as quiet as possible, and a well-balanced diet is also essential.

Cannibalism. — It is an instinct common in guinea pigs to devour all young that are immature at birth. Sometimes this cannibalistic instinct involves the eating of the live as well as the dead young.

Cannibalism is believed to stem from a dietary deficiency. Certain elements, particularly minerals, may be lacking in the diet and the animals devour their young in an attempt to satisfy a craving for these elements. A deficiency of this nature is also indicated if the animals gnaw at the wood or lick the whitewash on their pens.

Once the appetite has been developed, cannibalism in guinea pigs may be difficult to correct. The diet should be balanced by providing a variety of green foods.

Wounds. — Guinea pigs may be injured by fighting, especially among the males, or by rat, dog or cat bites. When this occurs, the hair around the wound should be clipped with scissors and this area washed with lukewarm water and dusted with disinfectant powder or sulfathiazole. It is wise to keep the animal separated from the others while the wound is healing.

Lice and Mange. – Guinea pigs sometimes become infested with long, narrow-bodied biting lice. The condition is indicated by a dryness and roughness of the coat, itchiness and loss of weight. Examination reveals the lice amid the hair.

In such cases the pens should be thoroughly cleaned and disinfected as recommended under *Paratyphoid Infection.* Each animal should be dusted with a flea powder containing derris root, rotenone or some other suitable insecticide. An alternative is to dip the animals into a solution of about 10 drops of creolin to 1 quart of warm water.

HAMSTERS

Characteristics

Mature hamsters are 6 to 10 inches long and their average weight is approximately 5 ounces. One of the outstanding characteristics of this rodent is its cheek pouches, in which the animal is able to carry about 2 ounces of grain. The male has an elongated, tapered body when viewed posteriorly, while the rear of the female is blunt. The latter is not as highly coloured as the male.

Both common varieties – the golden and the black hamster – make ideal pets and are useful in laboratory work as well. The golden variety is a golden-brown colour with black on the legs and belly and patches of white on the back. The cheek pouches and claws have white markings.

Black hamsters are pure black except for a white margin on the tail and ears. When the fur reaches its prime, the greyish colour at the base of the guard hairs becomes an orange-brown. Most white or coloured hairs have black tips.

If kept in a cold place, hamsters hibernate during the cold part of the year, usually from October to the end of April. As soon as the temperature drops below 50°F. they retreat to the nest. However, if the building in which they are housed is heated sufficiently, the animals remain active during the cold weather.

Hamsters being kept as pets should be handled and exercised as often as possible. They enjoy free runs and should be allowed the freedom of rooms in the breeder's home for certain periods of time each day.

Housing

Hamsters may be housed in hutches similar to those used for guinea pigs. A hutch measuring 22 inches long, 19 inches wide and 10 inches deep is recommended for each adult or for several young if the sexes are separated after they are 5 weeks of age. The structure should have a front opening, 4 inches long and 10 inches wide, covered with ½ inch wire mesh. To prevent the animals from gnawing through the wood, the hutch should be lined with wire screening, tin or perforated zinc, or angle strips of zinc or tin may be fixed to all interior corners. (An alternative deterrent is to soak the entire structure in creosote.) The same type of hutch, but measuring 30 inches by 10 inches by 10 inches, makes a good breeding pen.

In winter plenty of soft hay or cotton batten for bedding should be provided. It is a good idea to place a handful of sawdust in the hutch at the end farthest from the nest. This sawdust should be replaced daily. Protection should be afforded from dampness, draft and sudden changes of temperature.

Feeds and Feeding

Hamsters are not heavy eaters but require variety in the diet. The summer feeding should include fresh greens such as clover, dandelions, plantain and lawn clippings. In the winter, lettuce, celery, beet tops and uncooked vegetables should be provided. Mash should be given at all seasons, as well as hard, dry food. Finely ground bone meal and iron, soya bean flour and pellets similar to those fed to guinea pigs are important items in the diet of hamsters. Two drops of cod liver oil a day per three or four animals should be added to the meal.

Hay is too bulky a food for hamsters. Water is not essential but does no harm and may be dispensed from an inverted bottle equipped with a cork and glass tubing, as directed for guinea pigs.

Young hamsters should be fed twice a day until they are at least 6 weeks of age.

Breeding

Hamsters mature when they are between 28 and 45 days of age. Oestrus may first occur as early as one month after birth, and recurs in four-day periods. The female can become pregnant when around 42 days of age, but should not be bred until about 3 months of age. The gestation period is 15 or 16 days in duration.

The average litter is composed of seven or eight young. They are hairless and blind at birth, but are able to see about two weeks later. Under 6 weeks of age they are known as "kittens" and from 6 to 12 weeks are referred to as "cubs". At 12 weeks they are considered adult.

During the winter months, hamsters are reluctant to breed, but if breeding is desired before spring it is recommended that young stock between 3 and 3½ months of age, never bred before, be used. Females cease to reproduce when they become fully grown. The average life span of the hamster is from four to six years, but if used excessively for reproduction the animal may live only two years.

Diseases

Digestive Disturbances. – Hamsters are quiet susceptible to digestive disturbances occasioned by the feeding of unsuitable, spoiled or stale food. The sick animals lose weight and their fur becomes dull and rough.

To overcome such conditions, a variety of fresh, wholesome foods should be provided. The living quarters should be thoroughly cleaned. Medicinal treatment in the form of intestinal antiseptics may be given in very small amounts.

Deficiency Diseases. – Hamsters are very susceptible to deficiency diseases because they grow rapidly and eat only a small amount of food. The breeder must ensure that the diet supplies all the required nutrients in the proper proportions.

Cage Paralysis. – The first symptoms shown by a hamster affected with cage paralysis are inactivity and loss of the ability to rise. The animal crawls on its stomach with its nose on the cage floor, and death soon occurs. The condition may be caused by too small a proportion of green food in the diet, resulting in a vitamin B complex deficiency. Insufficient exercise may also be a contributing factor in cases of cage paralysis.

Pneumonia. – This respiratory disease appears when the living quarters are not kept absolutely dry, warm, well-ventilated and free from drafts. The animals "go off feed" and become dull, and the breathing is laboured. They die in a short time.

Cannibalism. – Like guinea pigs, hamsters sometimes eat their young due, it is claimed, to a mineral and vitamin deficiency. Some authorities are of the opinion that chewing the fur is another sympton of cannibalistic tendencies. A wholesome diet and plenty of exercise are recommended when such symptoms are noted.

Dystocia. – Difficulty in giving birth to young, known as dystocia, may occur when immature or runt females have been bred. Malformation of the pelvis may hinder the foetus from passing through the birth canal and death usually results.

Sterility. – It is believed that sterility, a fairly common condition in hamsters, is often caused by a vitamin deficiency. When animals are unable to produce young, it is recommended that more green food – chicory, if available, clover and dandelions – as well as wheat germ meal be provided as a possible means of correction.

Dental Troubles. – Hamsters' teeth may become excessively long if hard grains are not included in the diet. This deficiency causes an animal to display signs of a depraved appetite and gnaw on the cage until a tooth breaks. A broken tooth means a sore mouth and the animal, unable to eat properly, starves. With care and good feeding, dental troubles can be overcome.

Mange. – Evidence of mange, caused by a small parasitic mite, is first found on the ears of the hamster in the form of round, watery scabs, about the size of pin points. Later the forefeet, the region of the nose and mouth, and eventually the hindquarters are affected. The lower posterior part of the pelt becomes patchy and the animal walks with a body well raised on the legs. A considerable amount of weight is lost, and the animal finally dies.

When hamsters become infested with mange, they should be destroyed and the premises thoroughly cleaned. Breeding stock should be bought only when it is known that the animals are definitely mange-free.

Wounds. – Carelessness and faulty management will result in injury to the animals. A fall from an attendant's hand onto a concrete floor and fighting among males are common causes of injury. Unless they have been raised together, hamsters often fight furiously when mixed.

Injured animals should be kept by themselves in comfortable quarters. Disinfectants may be applied to teeth marks, scratches or lacerations after the wounds have been properly cleaned.

RATS AND MICE

Housing

Metal is the most satisfactory material to use in the housing of white rats and mice, since it permits the maintenance of a high degree of sanitation with a minimum of labour. Cages should be well ventilated; most of the front should be open and screened, while an air strip should be made on the top. Holes at both ends are not recommended since they would produce a draft. Dry bedding such as wood shavings, cotton batten or peat moss should be kept in the cage.

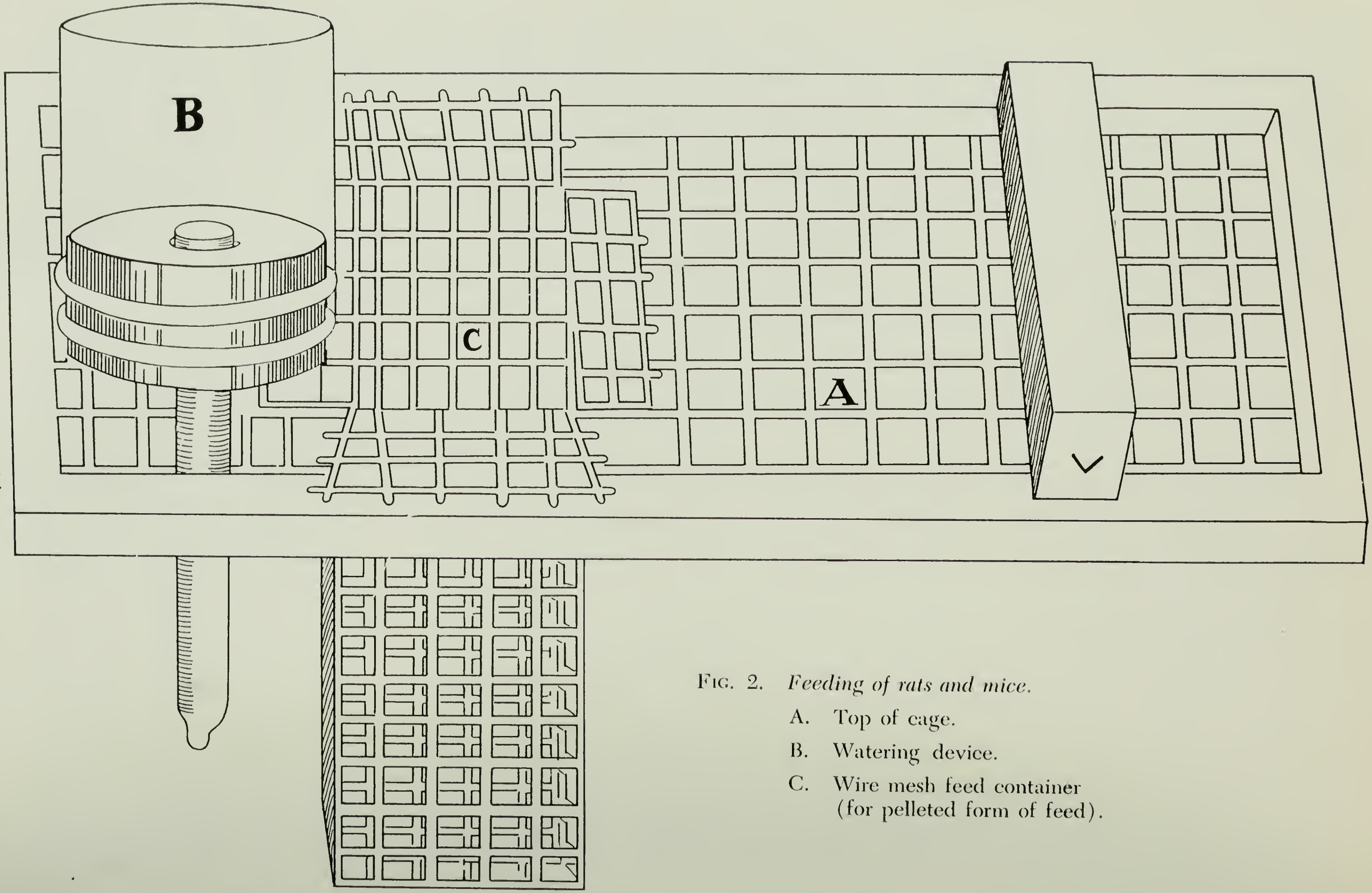

Fig. 2. *Feeding of rats and mice.*

A. Top of cage.

B. Watering device.

C. Wire mesh feed container (for pelleted form of feed).

Cages equipped with up-to-date devices for the care of rats and mice may be purchased from commercial supply houses, and persons who plan to raise these rodents extensively are well advised to utilize such equipment (fig. 1).

Feeds and Feeding

The pelleted form of feed is most economical. A mixture of such grains as yellow corn, wheat, hulled oats and hulled barley, all finely ground, should form the basis of the ration. Bone flour, powdered whole milk and cod liver oil may be added. Fox chow or cubes are also essential.

The following ration is recommended for breeding stock:

Water — Clean and fresh at all times.

Fox chow or cubes — Enough for one day at a time (¼ lb. to each 4 lb. prepared cake).

Prepared cakes — One cake of the following mixture daily, with 1 tbsp. dicalcium phosphate added:

Cracked wheat	1 lb.	Corn meal	½ lb.
Wheat germ	¼ lb.	Rolled oats	1 lb.
Wheat germ oil	1 oz.	Fish meal	½ lb.
Pilchard oil	1 oz.	Graham flour	¼ lb.
Soya bean meal	¼ lb.		4 lb.

Green feed — Spinach, lettuce or cabbage leaf daily.

Hard-boiled eggs — Once a week.

Rock salt — In the cage at all times.

Lime solution — One dessertspoonful added to the drinking water or milk.

Wire food receptacles should be used. Water may be dispensed from an inverted bottle hanging from the side of the cage (fig. 2).

Breeding

Mice are sexually mature at 48 days after birth, depending on their diet and strain, and may be bred at 58 days of age. Rats reach sexual maturity somewhat later and can be bred at 84 days. The gestation period of mice is approximately 20 days; of rats, about 21 days. The ovarian cycles are 3½ to 4½ days and 4½ to 5½ days respectively.

A breeding unit should be composed of one male and not more than 10 females. Small Ann Arbor cages are recommended — one for each breeding unit. When the females show signs of pregnancy they should be removed and placed in pairs in separate compartments. After each pregnancy they should not be bred again immediately.

Young mice should not be handled with the bare hands; if it is necessary to move them, forceps with padded tips should be used. When the young are large enough so that their sex may be determined, the males should be separated from the females. Mice are usually weaned when about 3 weeks old and rats at 4 weeks of age.

Diseases

Mouse Typhoid or Paratyphoid. — The organisms involved in these infections, *Salmonella aertryke* and *Salmonella enteritidis,* can greatly handicap research work in which rats and mice are used. Symptoms include soft, bloody excreta, particles of which are found clinging to the underside of the base of the tail. The animal is thin and somewhat inactive, with a dull, roughened coat. The mortality rate is high and reproduction decreases greatly.

Animals afflicted with such diseases should be destroyed. The cages should be thoroughly sterilized and kept out of use for 30 days.

Protozoan Infection and Tapeworms. — The chief source of protozoan infection and tapeworms is contaminated food. If grains have been heated to at least 170°F. during the milling and pelleting process, they are usually safe. Protection against tapeworms is afforded by keeping food in metal containers, as grain can be contaminated by faecal material containing tapeworm ova.

Respiratory Infections. — Unless suitable ventilation is provided, the atmosphere of a rodent colony becomes damp and objectionable, the animals sweat excessively and develop respiratory infections. A run-down condition is manifested, involving heavy breathing, light mucous nasal discharge, and watery discharge and soreness of the eyes. Properly constructed cages, dry bedding materials, and a consistently well-balanced diet are essential in the prevention of respiratory diseases among rats and mice.

Cannibalism. — An unbalanced diet or lack of drinking water my result in cannibalism.

ACKNOWLEDGEMENT

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BULLETIN 504

REVISED, APRIL 1955

Frozen FOODS

ONTARIO DEPARTMENT of AGRICULTURE
PARLIAMENT BUILDINGS - TORONTO, CANADA

FROZEN FOODS

This bulletin was prepared by a Committee consisting of:

PROFESSOR E. W. FRANKLIN, Department of Horticulture, Ontario Agricultural College, Guelph;

PROFESSOR E. S. SNYDER, Department of Poultry, Ontario Agricultural College, Guelph;

PROFESSOR E. C. STILLWELL, Department of Animal Husbandry, Ontario Agricultural College, Guelph;

DR. J. H. L. TRUSCOTT, Director, Horticultural Products Laboratory, Horticultural Experiment Station, Vineland.

MRS. M. JEAN CLARKE, Horticultural Experiment Station, Vineland.

FOREWORD

This bulletin is intended for householders who use the freezing method for the preservation of part of their food supply.

The first section covers problems which are common in frozen foods. Succeeding sections contain discussions on the processing of fruits, vegetables, poultry, meats, and cooked foods.

The authors of the various chapters will emphasize any difficulties in the freezing method of preservation in an endeavour to prevent disappointment in the quality of frozen foods and to prevent actual losses in frozen foods. The freezing method is, on the whole, a simple procedure, but, even slight deviation from well proven procedures can result in serious loss in eating quality, and carelessness or ignorance can result in inedible or even dangerous products.

INDEX

INTRODUCTION TO HOME FREEZING 3
- Why Foods Spoil 3
- How Freezing Preserves Food 3
- Care and Use of Your Home Freezer 4
- Packaging 9
- The Locker Plant 12

FROZEN FRUITS 15

FROZEN VEGETABLES 23

FROZEN POULTRY 35

FROZEN MEATS 53

FROZEN COOKED AND PREPARED FOODS 65

INTRODUCTION TO HOME FREEZING

by E. W. FRANKLIN

WHY FOODS SPOIL

Perishable foods such as meats, poultry, fruits, vegetables, and prepared foods soon spoil when kept at ordinary room temperature. The spoilage is usually caused by one or more of the following:

(1) Micro-organisms (bacteria, moulds, and yeasts) — small plants that feed on the food products causing decay, rots, and putrefaction.

(2) Enzymes — chemical substances which are naturally present in foods and usually cause undesirable changes in odour, flavour, colour, texture, and nutritional value.

(3) Drying — loss of water from the foods by evaporation. This results in shriveling and general unpalatability.

(4) Atmospheric Oxygen — oxygen from normal air acting alone or in conjunction with enzymes can cause discolouration, rancidity, and other harmful effects on perishable foods.

HOW FREEZING PRESERVES FOODS

Lowering the temperature of a perishable food reduces the harmful activities of both micro-organisms and enzymes. The freezing method of preserving foods makes use of this principle. Micro-organisms are completely inactivated

The chest-type (left) is still a very popular home freezer, although the upright-type (right) is preferred by many housewives because it can usually be conveniently located in the kitchen.

at 0° F. and although enzyme activity is not stopped it proceeds at a very slow rate. Furthermore, the foods are protected against drying and atmospheric oxygen by sealing them within moisture-vapour-proof materials.

However, merely using a 0° F. storage temperature plus moisture-vapour-proof packages does not satisfactorily preserve all frozen products. For example, vegetables require a heat treatment (blanching) before freezing to destroy most of the enzymes. Fruits should be covered with a sugar syrup to assist in retarding enzyme activity and to protect the fruits from atmospheric oxygen. Depending upon the product, other practices may be necessary to protect satisfactorily the quality before, during, and after frozen storage. These will be discussed in the succeeding sections dealing with various frozen foods.

CARE AND USE OF YOUR HOME FREEZER

Present day home freezers are carefully constructed and operate automatically. They usually give many years of trouble-free service. However, to get the most in service and the best results you should learn all about your freezer and how to use it to the best advantage. Read carefully and follow the instructions enclosed with the unit by the manufacturer.

Location

The freezer should be in a convenient and well-ventilated location. Space permitting, the best place is in the kitchen. Preferably, to reduce the operating cost position it away from a stove, radiator, or direct rays of the sun. A freezer located in a cool basement will cost less to operate than in the kitchen; but, if the basement is damp, rusting may be a problem. In such circumstances, cover the metal on the underside of the freezer with aluminum paint and keep the exterior finish waxed.

Operating Temperature

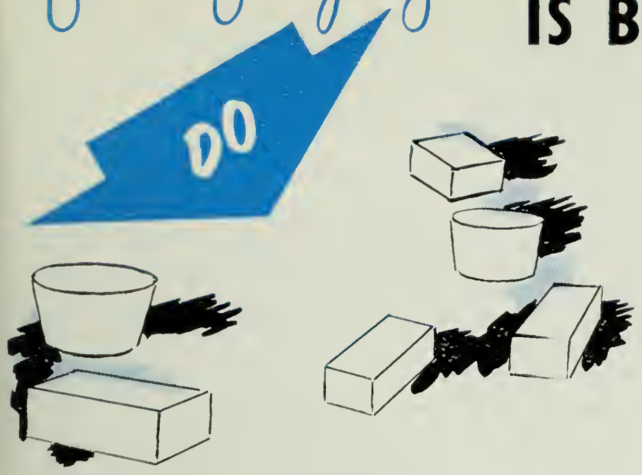
Frozen foods should not be stored at a temperature higher than 0° F. or the quality may suffer. Thus, adjust the control on the freezer so that it will operate at a temperature not higher than 0° F. You should check the operating temperature (to be certain that it is not above 0° F.) by placing a reliable thermometer in the centre of the freezing compartment, or install a relatively inexpensive distance reading thermometer. The indicating dial of this thermometer is hung on the wall by the freezer and it shows at a glance the temperature within the freezer.

Capacity

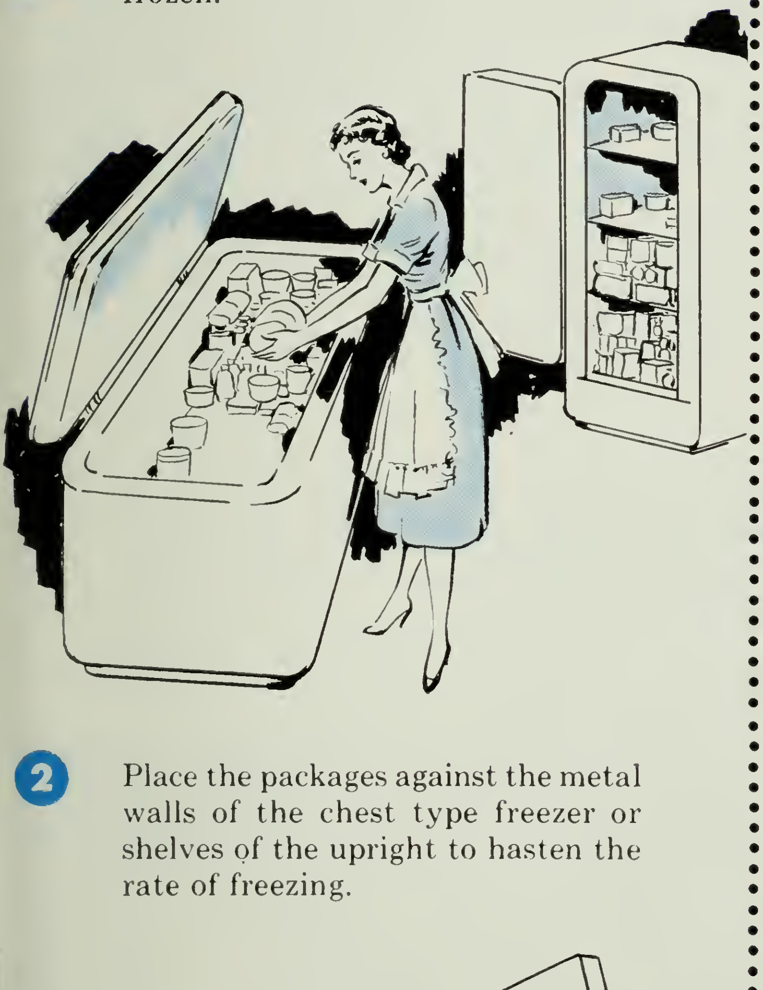
Usually the manufacturer of your freezer will include instructions on the number of pounds of food that your particular model will freeze in a 24-hour period. Such advice should be followed faithfully. Overloading a freezer with warm food will result in very slow freezing of the product. Under such conditions, the quality of the product will suffer and in some instances spoilage may occur before the product is frozen. Also, the frozen products already in the freezer may partially thaw, a condition that is very undesirable.

As a guide, most home freezers can freeze from 2 to 4 pounds of food per cubic foot capacity per 24 hours. A freezer in a cool location has a greater capacity for freezing foods than in a warm location. Also, a freezer can freeze more pounds of cool food in a given time than it can warm food. Packages

fast freezing IS BETTER THAN *slow freezing*



① Small packages freeze faster. Scatter the packages until their contents are frozen.



② Place the packages against the metal walls of the chest type freezer or shelves of the upright to hasten the rate of freezing.

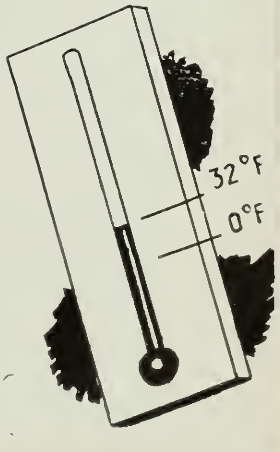
③ Use the lowest temperature available for freezing. It should not be higher than 0° F.

① Large packages freeze slowly. Close piling slows the rate of freezing.

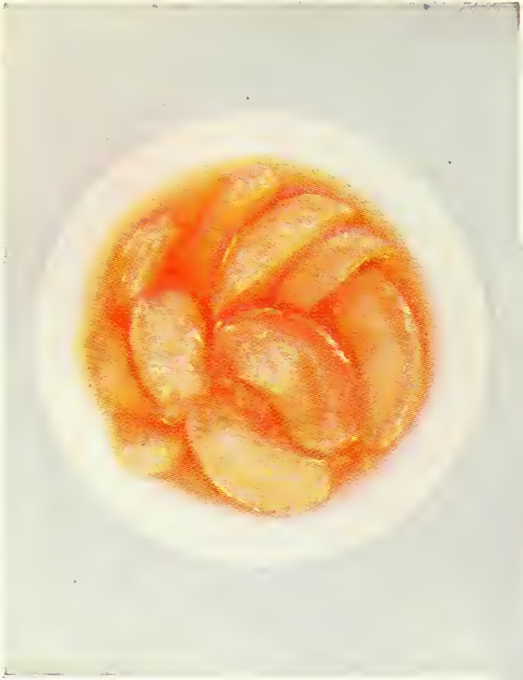
② Foods in a locker freeze slowly and their quality will suffer.

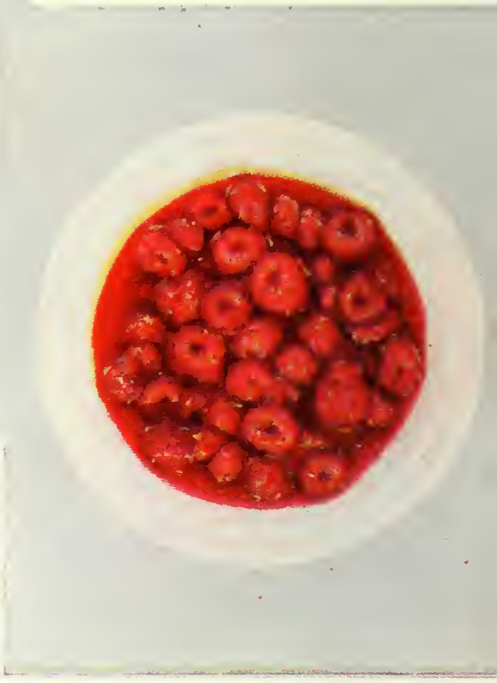
Always sharp freeze (fast freeze) foods before storing them in the locker.

③ Food will freeze at temperatures a few degrees below 32° F. but it freezes too slowly. Too many undesirable changes take place.



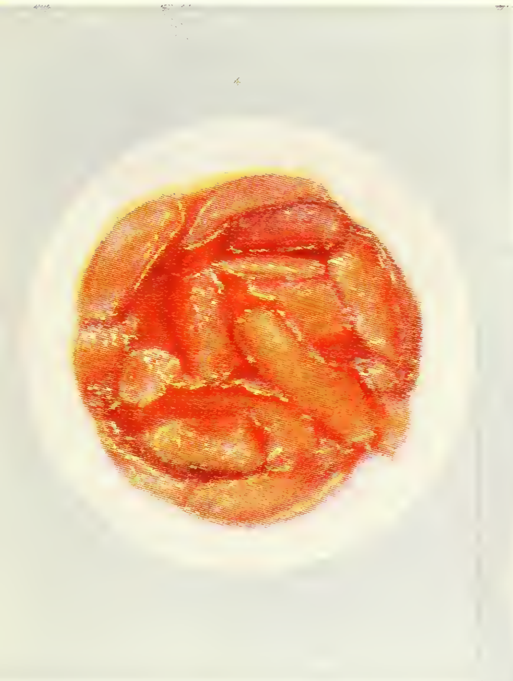
FROZEN FRUITS



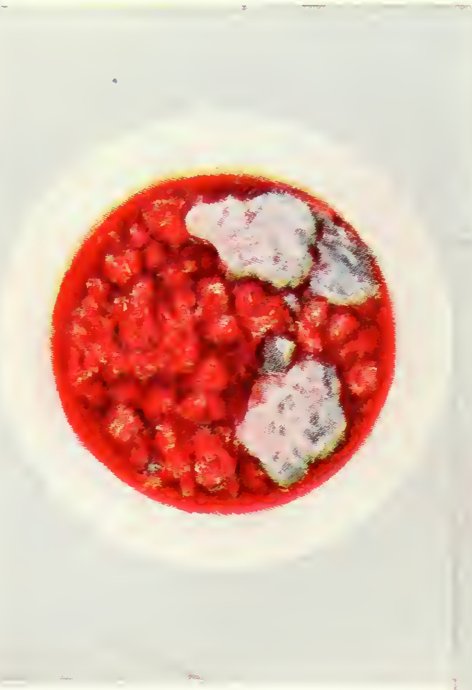


Should look like these:

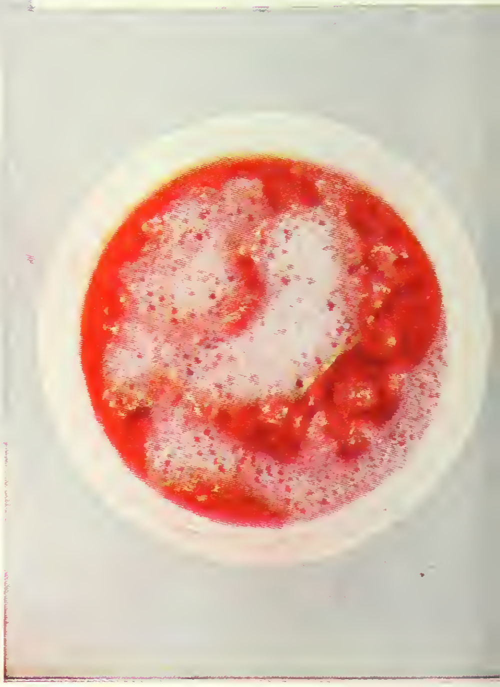
Not like these:



Oxidized



Mouldy



Fermented

containing liquids, for example, soups, juices, fruits in syrup, etc., contain more heat pound per pound and take longer to freeze than relatively dry products, such as meats, bread, pastries, etc.

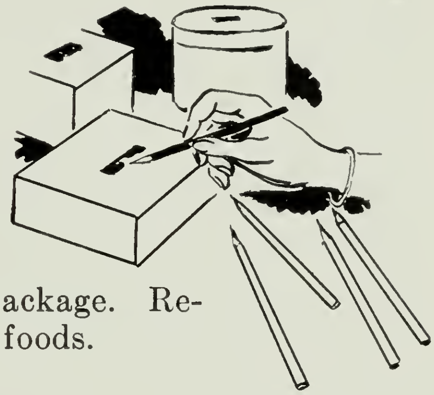
If you have a large quantity of food to freeze at one time by all means have it sharp frozen at a locker storage and then place it in your freezer.

Rate of Freezing Foods

Rapid cooling and freezing are essential in order to obtain high quality in the frozen foods. Merely limiting the number of pounds of food placed in a freezer at a given time is not the only precaution to observe. The packages of food to be frozen should be relatively small in size and never placed in a group, but should be spread out and, insofar as possible, placed directly in contact with the cold wall or plates of the freezer. When the products are completely frozen they are then, and only then, tightly stacked in their location for storage.

Good Housekeeping

Arrange the respective frozen foods in groups in order to save time when looking for a particular product. Products may also be located quickly by specific colour markings, either with coloured pencil or the more readily seen coloured labels cut from locker tape. Always date the packages and keep your stock fresh by using the oldest package. Remember that it is poor economy to hoard frozen foods.



Defrosting

Frost accumulation on the walls or plates of a freezer acts like insulation. It impedes the efficient operation of the unit and should be removed when approximately ¼ inch in thickness. Under normal conditions this should not be necessary more than once or twice a year. It is accomplished by simply scraping off the accumulated frost with a wooden paddle or a plastic type scraping tool (a windshield scraper is satisfactory). Do not use a knife or other metal instruments. The loosened frost is swept up with a whisk and removed. The frozen products need not be removed from the freezer provided there is sufficient room to shift them out of the way.

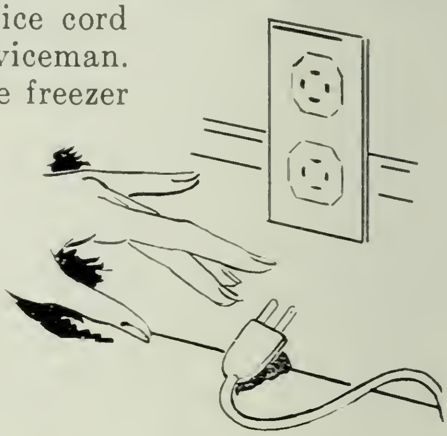
A thorough cleaning should be given if the walls or plates of the freezer have accumulated a thick coat of hard ice which scraping will not remove or if the interior of the freezer is dirty from spilled products. Switch off the freezer. Spread a thick layer of previously chilled newspapers on the table or floor and stack the frozen products in a compact pile. Cover the pile with more newspapers and several blankets. To hasten the defrosting process place an electric toaster in the freezer and close the lid or door; or, place an electric fan so that it blows directly into the freezer. When the ice has melted, mop up the water, wash the interior surface with soap and water, and wipe dry. Switch on the freezer and reduce the inside temperature to zero before putting in the frozen foods.

Odours

Obnoxious and persistent odours are seldom a problem in freezers except when food spoilage occurs as a result of power or mechanical failure. In such cases the odour apparently gains access to the insulation and is adsorbed by it. Ordinary cleaning of the interior does not remove it. Complete removal of the odour may require months. Mild solutions of baking soda, vinegar, and household ammonia may be used to ensure that all traces of the odour are removed from interior surfaces. In order to hasten its removal from the insulation, alternately heat (electric heater with lid or door closed), air out, and cool the freezer. Continue this treatment until the odour has diminished considerably. When the freezer is put into use again, place a bag inside containing a few pounds of activated charcoal which will absorb any residual odour.

Power or Mechanical Failure

The frozen food in your freezer is of considerable value. Precautions should be taken to prevent loss of the food through spoilage as a result of the freezer motor stopping, which may occur without your knowledge. If the freezer stops suddenly, check both the connecting service cord and the fuse in the circuit before calling a serviceman. This may save needless expense. Preferably, the freezer should have a battery-alarm system to warn the owner whenever the temperature rises above a safe level. A distance reading thermometer, previously noted, is very helpful in keeping a close check on the temperature within the freezer. Also, an insurance policy may be purchased which compensates for loss of frozen food through mechanical or power failure.



When the freezer stops, the situation is far from alarming. A well-filled chest-type freezer usually requires 2 to 3 days before the temperature of the stored products has risen to a dangerous level. Although products will thaw faster in an upright-type freezer than in a chest-type freezer there is usually plenty of time for power failures to be remedied or repairs made to the refrigeration unit. If a long power failure is anticipated, dry ice, if available, will keep the products frozen indefinitely. Wrap the sheets of ice in a few thicknesses of newspaper and lay them on top of the frozen foods in a chest freezer or on the top shelf of an upright. Otherwise, the frozen foods should be removed immediately to another zero storage.

Refreezing Thawed Frozen Foods

When, unknown to you, the freezer stops, the frozen foods may partially or completely thaw before discovery. The problem arises of what to discard and what may safely be refrozen.

If some ice crystals are still present in the packages all of the products may be refrozen without risk of food poisoning. If the products have thawed completely but are still relatively cool (temperature not above 50° F.), refreeze fruits, meats, poultry, fish, and cooked products but discard vegetables. When the products have been thawed for some time, and/or the temperature has risen above 50° F., examine each type of food carefully. Discard as a safety measure the vegetables, processed meats, and fish. If the other meats and poultry still have a fresh odour they may be cooked thoroughly and eaten without risk. Refreezing is not recommended but would probably be safe, provided the meats and poultry are well cooked before using later. Fruits ferment rather than putrefy; therefore, even though thawed for some considerable time, fruits may be safely refrozen. However, the colour, flavour, and texture may be undesirable. In this instance they can be made into jam.

Under no circumstances should you attempt to refreeze a large quantity of thawed food in the freezer. Its capacity to freeze is limited and before the foods become frozen (perhaps 1 to 2 weeks or more) more spoilage could occur. Pack the food into hampers or boxes lined with newspapers to be taken immediately to the nearest locker plant or commercial storage for refreezing.

Maintenance

The instructions enclosed with a home freezer should be studied carefully. Some home freezers are equipped with a condensing unit that requires periodic attention in order to maintain it in good operating condition. The maintenance required depends upon the particular type of condensing unit. Home freezers are usually equipped with one of the following three types of condensing units:

(1) Hermetic Unit with Static Condenser. The motor and compressor are sealed in oil in a steel housing and should operate for years without attention. The static condenser is cooled by radiation and natural air currents. Thus, this type of condensing unit requires no maintenance.

(2) Hermetic Unit with Finned Condenser Cooled by a Motor-Driven Fan. The hermetic unit is similar to that described in (1) and does not require attention. The finned condenser should be cleaned periodically with a brush or vacuum cleaner to remove any accumulated lint and dust. The fan motor may or may not require periodic oiling, depending upon its construction. Request information on this point from the dealer or manufacturer.

(3) Belted Unit with Finned Condenser. The compressor is belt-driven by the motor. Usually the condenser is cooled by a fan mounted on an end of the motor shaft. Oil the motor bearings twice a year by placing SAE 10 automobile oil in the two cups provided. Periodically, clean lint and dust from the condenser. Check the belt occasionally for tightness and indication of wear.

Operating Costs

The electrical consumption of a home freezer will vary depending on the make, size, location (warm or cool), and use. Thus, only an approximate estimate of electrical consumption can be given here.

Studies made both here and elsewhere indicate that home freezers in the 12 to 16 cubic foot size range use an average of 5 kilowatt-hours per month per cubic foot of storage space. Smaller freezers use proportionately more electricity and larger freezers proportionately less.

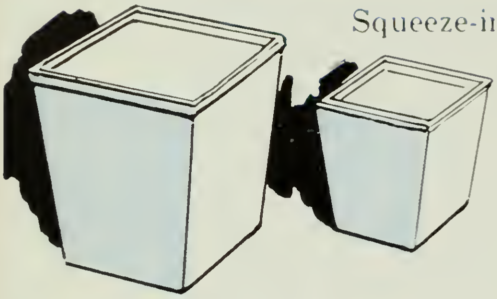
The cost of electrical power will vary considerably for different homes. At a rate of 1.5 cents per kilowatt-hour it will cost approximately $1.20 per month to operate a 16-cubic-foot freezer.

PACKAGING

Frozen foods must be tightly sealed in moisture-vapour-proof (MVP) containers and wrappers to keep the moisture in and the air out. Improperly packaged frozen foods dry during storage, resulting not only in an unattractive appearance (called freezer-burn) but also in greatly lowered quality. MVP packaging supplies are usually available at locker plants, paper supply stores, and mail order houses.

(MVP)

packaging materials for frozen foods

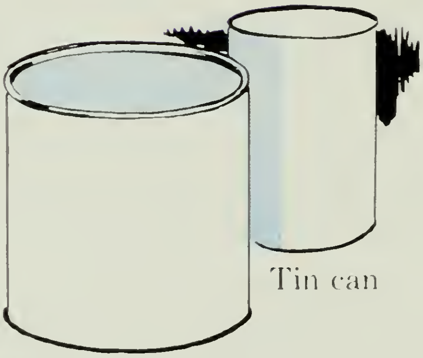


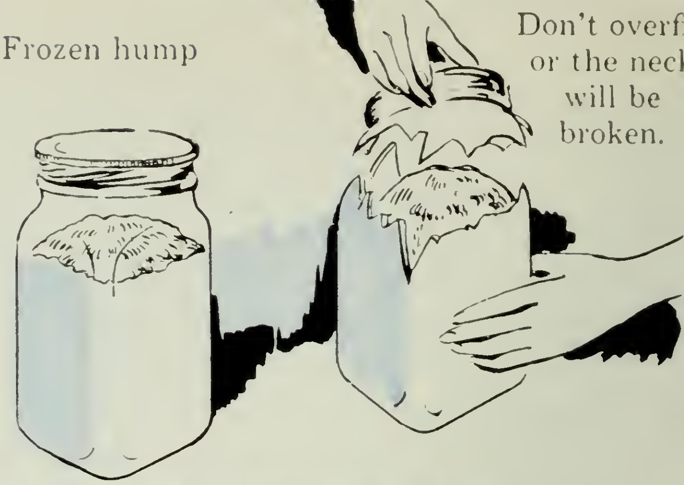
POLYETHYLENE CONTAINERS

(for cooked mixtures, fruits, vegetables, and soups)

TIN CONTAINERS

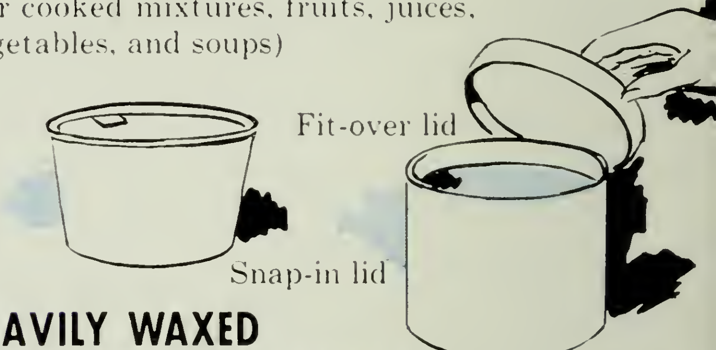
(for cooked mixtures, fruits and vegetables)





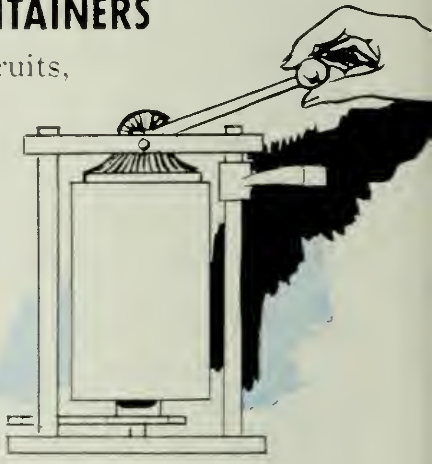
QUART OR PINT MASON JAR

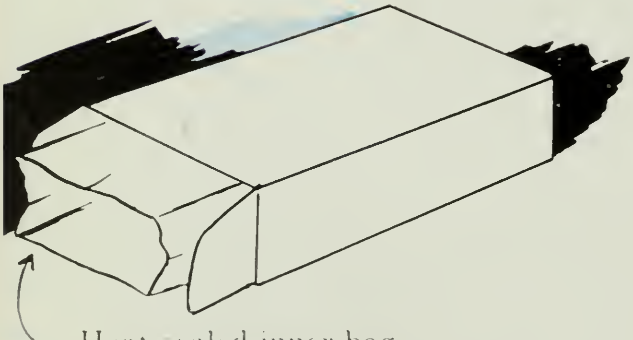
(for cooked mixtures, fruits, juices, vegetables, and soups)



HEAVILY WAXED CARDBOARD CONTAINERS

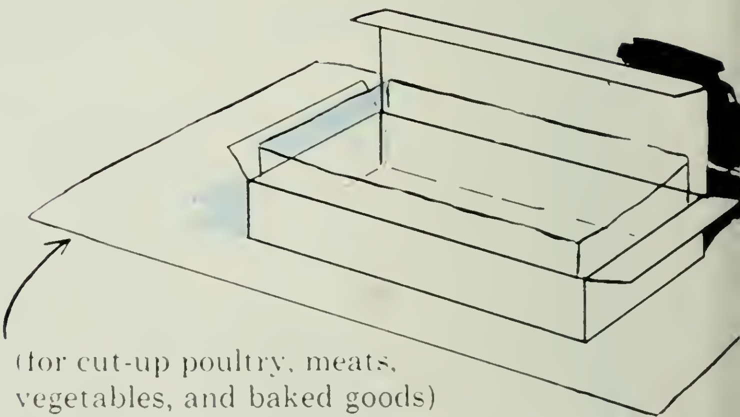
(for cooked mixtures, fruits, vegetables, and soups)



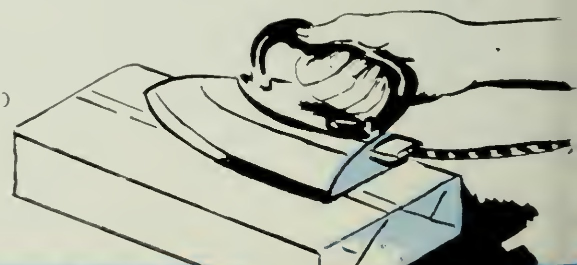


RECTANGULAR WAXED CARDBOARD CARTONS

(for vegetables)



(for cut-up poultry, meats, vegetables, and baked goods)



MST CELLOPHANE

(for cakes, pies, sandwiches, rolls, poultry and meats)

LOCKER PAPER (FREEZER PAPER)

(for poultry and meats—double wrap and tape joints)

ALUMINUM FOIL

(for poultry, meats, pies, cakes, sandwiches, cheese and corn-on-cob)

COMMON BUTCHER PAPER

(don't use except for protection for a few days only)

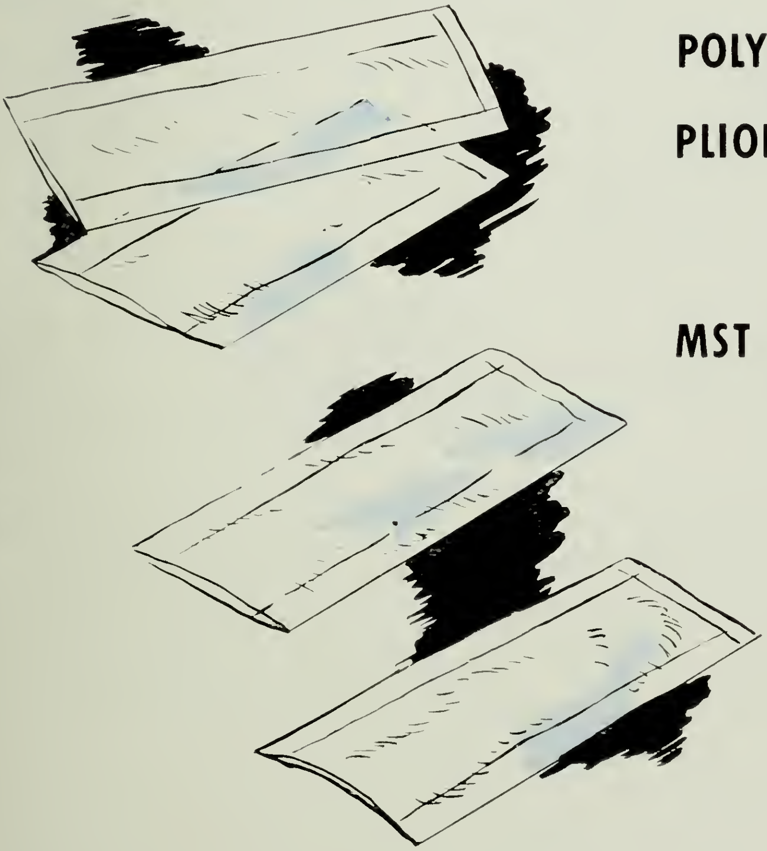
COMMON WAX PAPER

(don't use except for protection for a few days only)

LOCKER TAPE

(for sealing joints of wrapping materials)

MVP BAGS



POLY (POLYETHYLENE)

PLIOFILM

(for vegetables, including corn-on-cob, poultry, meats, salad blocks, quick breads and cookies)

MST CELLOPHANE

(for quick breads, rolls and sandwiches)

CRY-O-VAC

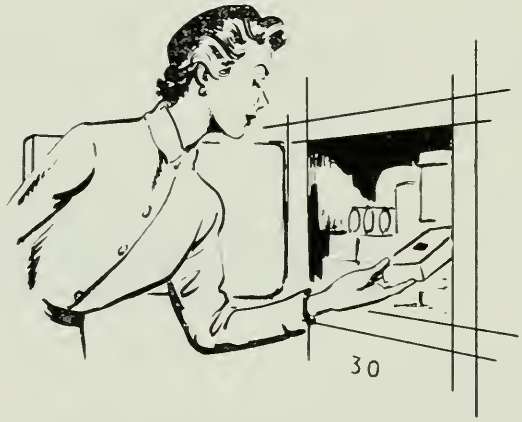
(for poultry and roasts)

Heat Sealing: MST* Cellophane is easily heat-sealed with a moderately warm flat iron, curling iron, or special heat-sealing iron. Pliofilm and polyethylene materials are also heat-sealable. However, the operation requires rather exacting conditions of temperature and technique and is not commonly done in the home. If heat-sealing pliofilm and polyethylene is attempted, use a slip-sheet of plain (not MST) Cellophane between the material and the warm iron.

Taping: Common gummed paper tapes and scotch tape are seldom satisfactory for sealing joints of frozen food packages. They tend to loosen and peel off at low temperatures. Use locker tape (sometimes called freezer tape) for sealing the joints.

Sealing Bags: Heat-seal MST Cellophane bags. For pliofilm and polyethylene (poly) bags, twist the neck of the bag, fold the twist over, and secure it with an elastic band or other suitable retainer. Always press out as much air as possible when sealing frozen foods in bags.

Overwrapping: Cellophane becomes brittle at low temperatures and breaks quite easily when handled. Also, aluminum foil may be punctured easily. Thus, if either of these materials is used for wrapping irregular-shaped pieces of food such as poultry or meats, it is advisable to protect the MVP wrapper with an overwrap of paper or mesh cloth known as "stockinette."



Headspace: Food expands as it freezes. Therefore, leave about ½ inch headspace in cartons containing tightly packed foods, and more for fruits packed in syrup. In glass jars allow at least 1½ inches headspace. Loosely packed products such as cauliflower and spinach do not require a headspace.

Don'ts: Ordinary butcher paper or waxed paper should not be used for wrapping frozen foods except when they are to be stored for only a few days. These materials are not sufficiently moisture-vapour-proof.

Labelling: All packages should be marked with a description of the contents and the date when frozen.

THE LOCKER PLANT

The modern locker plant offers many services in connection with processing, storing, and selling frozen foods.

Lockers are rented to individuals for storing frozen foods. Butchershop facilities are usually available for slaughtering, cooling, ripening, sausage-making, and curing. Meats are cut, wrapped, and frozen for storage in lockers or home freezers. Usually all kinds of frozen foods are stocked for sale. Some locker plants sell frozen foods at a quantity discount to locker renters or owners of home freezers. Most locker plants stock packaging materials for home freezing.

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* M — moisture-proof; S — heat-sealing; and T — transparent.

Locker plants in Ontario operate under license from the Provincial Government. Conditions in the plant pertaining to public health and food quality must meet requirements before a license can be obtained. Amongst other things the regulations require that all foods shall be of good quality, properly prepared and packaged, and sharp-frozen before being placed in a locker. Locker renters should write to the Department of Health of the Provincial Government for a copy of the Regulations under the Public Health Act in respect to Frosted-Food Locker Plants.

The services offered by the locker plant may be very useful to the owner of a home freezer. For example, as a source of packaging supplies, sharp-freezing quantities of food, quantity buying of frozen foods, and storage should the home freezer become inoperative because of power or mechanical failure.

For the best flavour, slice Strawberries and add sugar before freezing.

Frozen FRUITS

by J. H. L. TRUSCOTT and M. JEAN CLARKE

The appearance and eating quality of some fruits are better preserved by freezing than by any other method. Freezing also effectively preserves food values which cannot be seen or tasted.

But freezing is not without faults. A clear view of some of its shortcomings may prevent future disappointments and food losses.

Actually no known method keeps a food in exactly its original condition. Changes always occur in colour, texture, flavour, odour and food value. Such changes occur not only during the process of preservation but also as the food "ages" while it is held for future use.

A few kinds of fruit are so adversely affected by freezing that no one could enjoy eating them. For instance, colour, crispness and flavour are changed greatly in a whole, frozen apple.

Many varieties of each kind of fruit are not well preserved by freezing. Consequently, during the past twenty years, this and other laboratories made freezing tests on hundreds of new varieties of fruit supplied by plant breeders. The search for better varieties for freezing is still very active.

Most of the principles and procedures for making, holding and using high quality frozen fruits are well established. In most instances any substantial deviation from them will result in lower quality.

Within certain limits the housewife can and should vary the size of pieces of fruit to be frozen, depending on its future use. For instance, she may want some strawberries frozen whole for decoration of shortcakes. But likely she will prefer the much better flavoured, sliced berries packed with sugar as the filling. Finally if she wishes later to make strawberry ice cream she would probably mash the raw fruit and mix it with an appropriate amount of sugar before freezing it.

Within limits the housewife can vary the size of package so that her family can use all of it at one time.

She may also prefer the flavour or colour of one variety of fruit to another. For instance, she might prefer a peach with a red centre to one which is yellow. There is an interesting range of flavours in most fruits among varieties known to be well preserved by freezing.

SUGAR

Some fruits may be frozen without a covering liquid, but the flavour of all fruits is better preserved when the fruit is covered by a syrup. Syrup is a necessity for those fruits which brown readily in contact with air.

Syrup refers to mixtures of sugar and water. When sugar is mixed with sliced or crushed fruit it dissolves in the fruit juice. In both instances the resulting liquid protects the fruit from oxygen in the air.

Sugar, when dissolved in either water or fruit juice, penetrates the fruit and acts as a preservative of colour, texture and flavour.

The strength of syrup used depends partially on personal preference. The weakest syrup which affords the necessary protection to the fruit contains approximately 25% to 30% sugar, or that known as a "light" syrup in home canning procedures. Medium syrups may be used, if preferred, and they sometimes provide better protection of flavour and texture than a light syrup. We find that the excessive sweetness of heavy syrups masks the flavour of the fruit.

We make the syrup by adding sugar to cold water and dissolve it by stirring. We find no advantage in boiling the mixture. The syrup should be as cold as possible when added to the fruit.

A 25% syrup consists of 25 ounces of sugar to 75 ounces of water. The proportion is 1 of sugar plus 3 of water by weight. Sugar and water weigh approximately alike, so that 1 cup of sugar added to 3 cups of water will provide an approximate 25% syrup.

Many fruits taste better if they are sliced or crushed and mixed with dry sugar before freezing. A proportion of 1 of sugar to 5 or 6 of fruit by weight contains enough sugar to protect the fruit flavour. More sugar may be used if desired. The sugar dissolves in the sliced or crushed fruit juice as the mixture is stirred gently. A soft rubber spatula is a good tool for the job. It is difficult to give volume measurements for the different fruits, but if a scale is not available the following table will give some idea of volumes of fruit and sugar for an approximate 1 to 5 mixture.

Fruit	Standard Container	Weight of Prepared Fruit	Sugar to Add
Berries	6 1-quart boxes	7½ lb.	3 cups
Cherries	1 6-quart basket	7½ lb.	3 cups
Peaches and Apricots	1 6-quart basket	9 lb.	3½ cups
Plums	1 6-quart basket	7½ lb.	3 cups

VITAMIN C

Vitamin C (also known as ascorbic acid and by various trade names) is sometimes used with fruits which turn brown readily as a result of contact with oxygen in air. The vitamin tends to remove oxygen from the fruit-syrup mixture and thus reduces the amount of browning.

The chemical is obtainable from locker plants, drug stores, and, sometimes, grocery stores. The user is advised to follow directions on the package.

The usual recommendation is to use about 200 milligrams (about ¼ teaspoon) of the pure chemical per pound of fruit-syrup mixture.

USING FROZEN FRUITS

Thawed fruits deteriorate quickly and it is therefore advisable to use them at once. If there is unavoidable delay, keep the fruit in its container until immediately before it is to be used. Keep it cold.

Thawing may be done in a kitchen refrigerator, at room temperature, or, if needed hurriedly, the container may be placed in lukewarm water. The first method has the advantage that the food is kept cool until used. If lukewarm water is used the fruit should be removed immediately it is defrosted.

Jam or jelly made at intervals from frozen fruit will have a "fresher" flavour than jams stored for a considerable time.

If a batch of frozen fruit is low in quality due to the use of an unsuitable variety it is sometimes possible to use the material quite successfully as pie filling, stewed fruit or any other use in which the fruit is cooked.

Sometimes the only fruit available consists of varieties known to be poorly preserved by freezing. It is suggested that some of it be cut into serving pieces, heated for 2 or 3 minutes in boiling syrup, packed, covered with cold syrup and frozen. A small trial lot will be sufficient to discover if the pack is pleasing.

Unknown varieties of fruit may be tested by freezing a small sample in a household refrigerator or locker plant. It may be defrosted the next day. Examination will show if its quality pleases the processor.

Apple

Apples are frozen in the sliced form for subsequent use in pies. Apple sauce, made in the usual way, may be cooled and frozen. Sliced apples will become brown in colour and lose flavour unless treated before freezing. Various treatments are used in commercial production of sliced frozen apples, but the method suggested for home use is to slice the apples into a weak brine (about 1 teaspoon of salt to 1 quart of water) so that discolouration is largely prevented during the slicing operation. Then cook for a short time in boiling water. The time will vary depending on the variety of apple and its maturity. Overcooking will result in the slices becoming too soft. Undercooking will allow deterioration of the frozen product. About two minutes in boiling water is sufficient for the average lot of sliced apples. Pack in containers large enough for fruit for one or two pies. Freeze. Part or all of the sugar necessary for the pie may be added before freezing. Use favourite cooking varieties.

Apricot

Relatively few apricots are grown in Ontario. Halve the fruit and remove the pits. Cover with syrup. Freeze. This product is only fair in quality.

Blackberry

Pack as whole fruits in syrup or lightly crushed in sugar. This berry must be full ripe before freezing, otherwise the frozen berries become red in colour and are very sour. Suitable varieties have excellent frozen quality.

Black Raspberry (Black Caps)

Most varieties are best when lightly crushed with sugar. Most are good in syrup. If the available variety is unknown or if the berry is frozen for the first time it is suggested that most of the pack be the crushed fruit-sugar mix Flavour is powerful and usually well preserved.

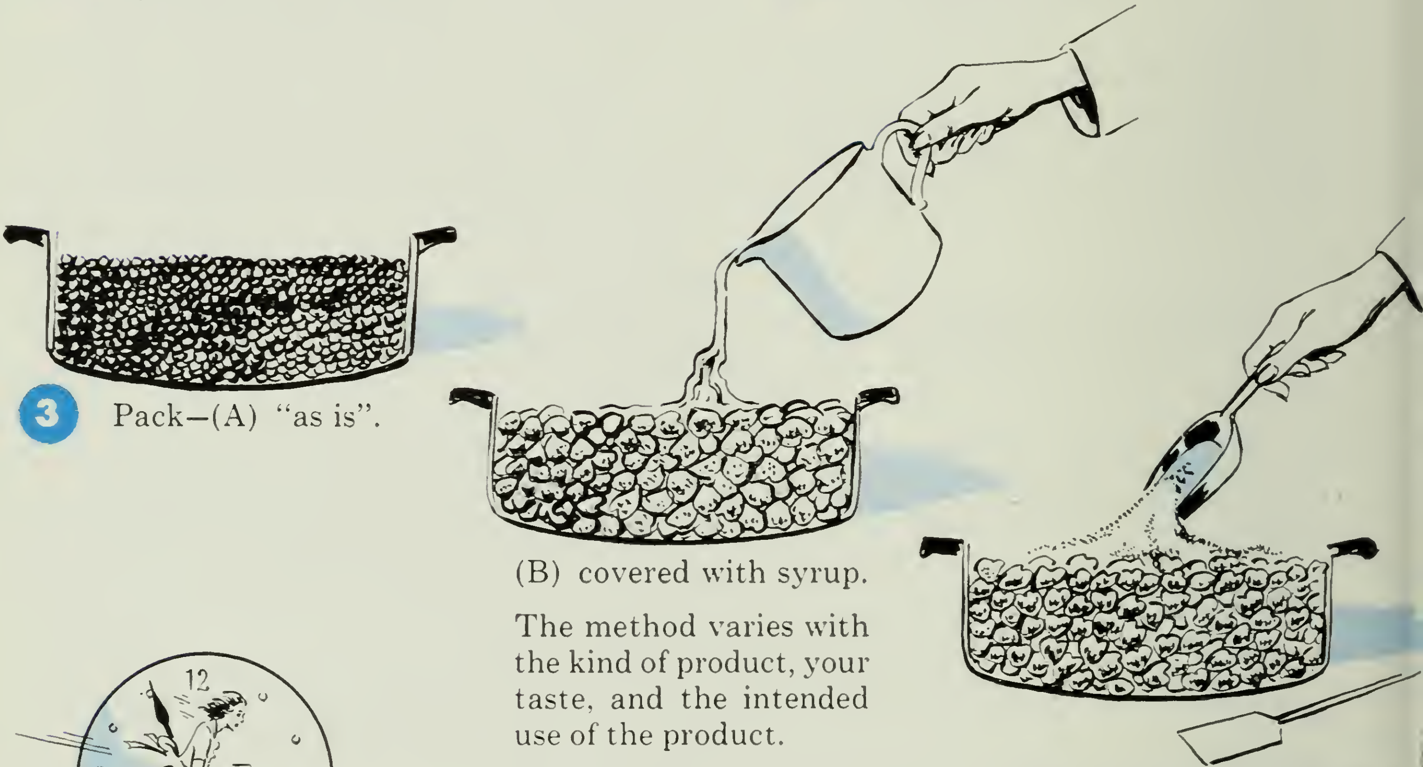
Cantaloupe

The claim is made occasionally that halves or even whole cantaloupe have been frozen successfully. Our experience is that much better results are obtained by cutting the edible portion into one-half to three-quarter inch cubes, or into rounded balls, before freezing. The pieces of fruit may be packed without sugar or syrup but we prefer a covering of light syrup. It is important that the fruits be eating ripe before freezing. We think frozen cantaloupe is interesting in winter salads.

FROZEN FRUITS

① Harvest when the fruit is firm, ripe or allow to ripen.

② Wash, trim, peel, core, cut into serving pieces.



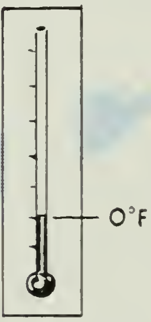
③ Pack—(A) "as is".

(B) covered with syrup.

(C) add sugar and dissolve it.

The method varies with the kind of product, your taste, and the intended use of the product.

④ Handle it fast.



⑤ Hold at 0° F., or colder.

⑥ Use it immediately after thawing.

Cherry (Sour)

Sour cherries freeze with excellent quality for pies. Pit them and add sugar. Allow most or all of the sugar to dissolve before packing. Use the amount of sugar preferred in pies. A syrup pack is good but there is more liquid than can be used in the pie.

Cherry (Sweet)

Light coloured sweet cherries freeze with only fair quality. The flavour is too mild and they tend to discolour. Several common varieties of black sweet cherries freeze with from fairly good to excellent quality when pitted and covered with syrup, or when sugar is dissolved in the pitted fruit. We prefer the sugar-fruit mixture.

Blueberry

This fruit grows only in areas having suitable soils. It is often frozen "as is" but its quality is improved when the berries are covered with syrup.

Currant (Red and Black)

Currants are usually frozen for use in pies or tarts. We prefer to add enough sugar for use in pies or tarts and to lightly crush the fruit so that most of the sugar is dissolved before freezing. Frozen black currants are a good source of vitamin C and most varieties, when ripe, freeze with excellent quality. Black currant addicts may like the uncooked fruit-sugar mix on toast or as a relish. All tested varieties of red currants were suitable for freezing.

Cranberry

This fruit grows only in areas with special soils. It is ordinarily frozen "as is." It is an excellent product.

Gooseberry

Most gooseberries are marketed immature and green in colour. We prefer to cut the berries in half and add the amount of sugar necessary for pies or tarts. Allow the sugar to dissolve before freezing. Ripe gooseberries are relished by many persons. They may be frozen "as is" or with a covering of syrup, or mixed with sugar.

Grape

Grapes need special care in washing to remove undesirable spray deposits and other foreign materials. They may be frozen as small bunches or as detached berries. It is important that they be ripe. The characteristic flavour of each variety is preserved rather well by freezing. The berries of some varieties split when they are frozen. We prefer a covering of light syrup. The recommended varieties should provide a satisfactory product if those varieties are relished in the fresh condition. Only small trial lots are recommended.

Peach

The eating quality of frozen peaches can be very good and it can be extremely disappointing. A variety of peach may provide a good frozen product one season and an inferior one the next. It is difficult to maintain suitable texture in the soft flesh of a ripe peach and most of the commoner varieties tend to discolour readily.

The most reliable method of preparation is to peel and pit the firm-ripe fruit, slice it into eighths or twelfths, add sugar (about 1 pound to 6 pounds of sliced fruit), turn the mixture with a rubber scraper a few times, carefully, until the sugar is dissolved and freeze. Vitamin C may be added as suggested earlier as an aid in reducing discolouration.

The varieties recommended usually provide satisfactory results. If autumn conditions are such that the fruit has been subjected to lengthy periods of cold temperatures before harvest, it is advisable not to freeze late varieties such as Elberta.

Pear

Frozen pear is not recommended.

Pineapple

This imported fruit is often frozen and the quality is good if the fruit is ripe. Dice the edible portions into half-inch cubes. It may be packed "as is," with sugar or with syrup.

Plum

Plums must be ripe before freezing. Cut the fruit in half and remove the pit. Many varieties freeze with only poor to fair quality, and only small, trial packs are recommended for those freezing plums for the first time. Prunes and Damsons are preferred to other types generally, and we prefer to cover the fruit with a light syrup.

Raspberry

Most readily available varieties of raspberry provide a satisfactory pack when lightly crushed and mixed with sugar. The Cuthbert variety may be relied upon to have good quality when frozen as a whole berry with or without sugar or syrup, but it is becoming increasingly scarce. Most varieties maintain their appearance and texture when frozen whole but the flavour of most of them is disappointing. The frozen quality of a variety of raspberry may vary considerably from season to season. Despite the above opinion of the frozen quality of whole raspberries, it is a popular frozen fruit.

Rhubarb

The red varieties of rhubarb are generally preferred for freezing. Harvest the tender early growths for best quality. The stalks are generally cut into inch lengths and frozen "as is." Or it may be partially or fully cooked before freezing. Frozen rhubarb of good quality is popular.

Strawberry

Most readily available varieties of strawberry when frozen whole retain only fair quality. They are soft in texture and the flavour may be altered rather seriously. The recommended pack for common varieties of strawberry is to slice each berry into 2 or 3 pieces, add sugar at the rate of about 1 pound to 5 pounds of berries, allow the sugar to dissolve with a minimum of stirring, pack and freeze.

The water used to wash the berries should be as cold as possible and used as briefly as possible. Otherwise the berries lose appearance quickly by becoming water-logged.

Watermelon

Watermelon balls might be tried as a novelty for salad. Both texture and flavour are retained surprisingly well. We prefer a sugar pack.

RECOMMENDED VARIETIES OF FRUITS FOR FREEZING

Those varieties marked xx or xx+ usually freeze with fair to fairly good quality. A xxx rating is given only to those varieties which generally freeze with retention of good quality.

Blackberry

- Eldorado (xx)
- Lowden (xx)

Cantaloupe

- Bloomsdale Sugar Cup (xxx)
- Delicious (xx)
- Early Leader (xx)
- Hearts of Gold (xxx)
- Iroquois (xx)
- Sugar Salmon (xxx)

Cherry (Sour)

- Montmorency (xxx)
- Early Richmond (xxx)

Cherry (Sweet)

- Black Tartarian (xx)
- Gill Peck (xxx)
- Hedelfingen (xx)
- Schmidt (xx+)
- Vernon (xx)

Currant (Black)

- Baldwin (xxx)
- Kerry (xxx)
- Magnus (xx)
- Naples (xx)
- Saunders (xxx)

Currant (Red)

- Perfection (xxx)
- Red Lake (xxx)
- Stephen's No. 4 (xx)
- Stephen's No. 9 (xxx)

Gooseberry

- Clarke (xxx)

Grape

- Agawam (xx)
- Concord (xx)

Peach

- Envoy (xx+)
- Redhaven (xx+)
- Sunbeam (xx+)
- Veteran (xx)

Plum

- Damson (xx)
- Italian Prune (Fellenburg) (xxx)
- Pacific Prune (xxx)
- Stanley (xx)

Raspberry (Red)

- Cuthbert (xxx)
- Rideau (xx)
- Viking (xx)
- Washington (xx+)

Raspberry (Black)

- Black Beauty (xxx)
- Bristol (xxx)
- Dundee (xxx)
- Evans (xxx)
- Logan (xxx)
- Morrison (xxx)

Strawberry

- Sparkle (xx)
- Valentine (xx+)

Watermelon

- Honey Cream (xx)

Frozen Peas give garden freshness to a meal.

Frozen VEGETABLES

by E. W. FRANKLIN

Although a large selection of vegetables may be successfully frozen, not all are suitable. Celery, cucumbers, lettuce, and radishes lose their desirable crispness after freezing. Tomatoes, either as whole, quarters, or slices, are seldom satisfactory as a frozen product, but tomato juice is quite acceptable.

HOW TO ENSURE HIGH QUALITY

Freezing vegetables is relatively simple, but to get the best results attention must be given to certain rules of procedure.

(1) Use Recommended Varieties

There are usually numerous varieties or hybrids of any vegetable. They differ considerably in quality after freezing; in fact, some may be very unpalatable. Therefore, grow or buy for freezing only those varieties which have been found by test to yield a high quality frozen product (see list of recommended varieties).

(2) Freeze at the Correct Maturity

A good variety for freezing can be ruined by harvesting it too soon. Also, allowing it to become overmature or permitting a delay between harvesting and freezing usually results in an inferior frozen product. Undermature vegetables are very soft and lack flavour after freezing, while overmature vegetables become tough and are scarcely palatable. The correct maturity for selecting vegetables for freezing is when they are tender and succulent — just right for immediate table use.

(3) Prepare Quickly and Carefully as for Table Use

Most vegetables lose quality rather quickly after harvest. They should be frozen the same day they are picked — within a few hours, if possible. If there must be a delay before preparing them for freezing, keep them in a refrigerator or some other cool place with a temperature not higher than 40° F., preferably as low as 32° F. Or, cool the vegetables in ice water and pack them in cracked ice.

Prepare the vegetables for freezing the same as for table use. Wash thoroughly, discard inferior material, and, where necessary, cut into serving pieces. Clean water, clean utensils, and clean hands are essential because vegetables are not sterilized by freezing and contamination by micro-organisms should be kept at a minimum.

(4) Vegetables Must be Blanched

Almost all vegetables are blanched (placed in boiling water for a few minutes) before freezing. Blanching is necessary to ~~kill~~ inactivate chemical enzymes that cause a loss in the quality of frozen vegetables during storage. Also, blanching deepens the natural colour of the product, partially sterilizes it, and makes it softer for packing. Unblanched vegetables lose colour and vitamins, become tougher, and develop peculiar, offensive flavours within a comparatively short time after freezing.

The necessary amount of blanching depends chiefly on the size of the pieces — for example, 2 minutes for peas and 11 minutes for large cobs of corn. In order to obtain a high quality frozen product the recommended length of blanching time for a certain vegetable should be adhered to strictly. Underblanching results in insufficient killing of the chemical enzymes and consequently an inferior product. Overblanching is less serious than underblanching but is nevertheless undesirable because it results in a loss of food value.

Blanching is accomplished by placing a small amount of the vegetable in a large quantity of water over a high heat source so that the water returns rapidly to a boil after the vegetable is put in. Not more than 1 minute should be required for the water to return to a boil. At least 1 gallon of water should be allowed for each pound of vegetable; 2 gallons for a leafy vegetable.

Place about 1 pound of the vegetable in a square of cheesecloth, wire basket, or screen, and place it in the kettle. Agitate the vegetable to ensure even heating. *Start counting the recommended blanch time only when the water returns to a boil.* A clock with a sweep second hand assists in accuracy.

At the end of the blanching period *cool the vegetable immediately in cold — preferably running water.* Prompt and complete cooling is important to ensure top quality. If running water is not available, use ice to keep the water cold. Continue cooling until the water draining out of the bottom of the bag or screen feels cold to the hand. Then, drain briefly, and proceed with packaging. Do not allow the vegetable to remain in the cooling water longer than necessary.

(5) Seal in MVP Packages

Almost any type of MVP carton may be used for storing frozen vegetables (see MVP Packaging Materials in Introductory Section). Rectangular, waxed, cardboard cartons which open at the end and contain a heat-sealable inner bag are especially popular. Also, poly bags are widely used, being simple to fill and close. Corn-on-the-cob does not pack well in cartons. Two or more ears may be sealed in a poly bag, or individual ears may be wrapped in aluminum foil or cellophane and then overwrapped with paper to protect the MVP material from punctures.

(6) Freeze Immediately and Store at 0° F. or Colder

Vegetables that have been prepared and packaged for freezing must not sit around at room temperature. Not only would the quality suffer but there is danger of spoilage. Place the packages in the home freezer as soon as they are ready (see Care and Use of Your Home Freezer in Introductory Section). If they are going to a locker plant, keep them in the coldest part of the kitchen refrigerator until all are ready. Then place in a carton and take them to the locker plant without delay. Packages of vegetables going into a locker must be sharp frozen first at the locker plant. This is not only a law but it helps to ensure high quality in the frozen product.

Experience has shown that the highest temperature for effective preservation of frozen vegetables is 0° F. A lower temperature would be better, but it costs more to maintain such conditions. High quality vegetables of suitable varieties, harvested at the correct maturity and properly prepared and blanched, should retain their high quality satisfactorily for at least one year when stored at 0° F.

(7) Cook Correctly

Frozen vegetables (except corn-on-the-cob) are best when not thawed before cooking. Merely thaw the vegetable sufficiently to remove from the package; place into the smallest amount of water that will cook it without scorching. Have the water boiling before the vegetable is added. Seasonings are added as desired. A pinch of monosodium glutamate (e.g. Accent) is worth trying. It improves the natural flavour of the vegetable. As soon as the vegetable is partially thawed, break it apart gently with a fork to insure uniform cooking. Use high heat until the water returns to a boil, then lower heat to finish cooking.

Do Not Overcook

Cook frozen vegetables for the shortest possible time — only until tender. They require only 1/2 to 2/3 the cooking time of corresponding fresh vegetables. Excellent frozen vegetables can be ruined by overcooking or by "keeping them hot" for an undue length of time after they are cooked.

Corn-on-the-cob should be completely thawed in its wrapper at room temperature before being cooked. It may either be boiled, or buttered and then roasted in a 400° F. oven for about 20 minutes.

Many frozen vegetables may be baked or pan-fried as well as boiled. Frozen vegetables such as asparagus, carrots, peas, and snap beans may be thawed at room temperature in their sealed packages and used without further cooking as salad ingredients.

Do not refreeze vegetables after thawing. The quality will suffer and there is always the chance of spoilage.

PREPARING VEGETABLES FOR FREEZING

Following is information for preparing various vegetables for freezing.

Asparagus

This vegetable loses its quality quickly after harvest unless it is chilled. Wash carefully in plenty of cold water. If it has been harvested after a driving rain it may be necessary to wash it in warm water to eliminate sand from the leaflets on the stem, or the leaflets may have to be removed. Chew some pieces from time to time to be sure the sand is gone. Freeze only the tender tips and trim them to fit the package used. The leftover green butts may be cut into short pieces and packed separately for a soup ingredient. Grade the stalks into two sizes — ½″ or smaller blanch for 3 minutes, larger sizes for 4 minutes. Cool, package, and freeze immediately. Asparagus is one of the excellent frozen vegetables, and it can be served in salad or after boiling for 3 to 5 minutes.

Beans, Green and Wax

The flavour of beans tends to be weak after freezing. Select small-seeded, crisp, tender pods. Sort and wash thoroughly. Snip off ends and break or cut into 1 inch pieces. Blanch 3 minutes, cool, package, and freeze immediately.

1. Use recommended varieties.

2. Harvest at the correct maturity.

3. Prepare quickly and carefully as for table use.

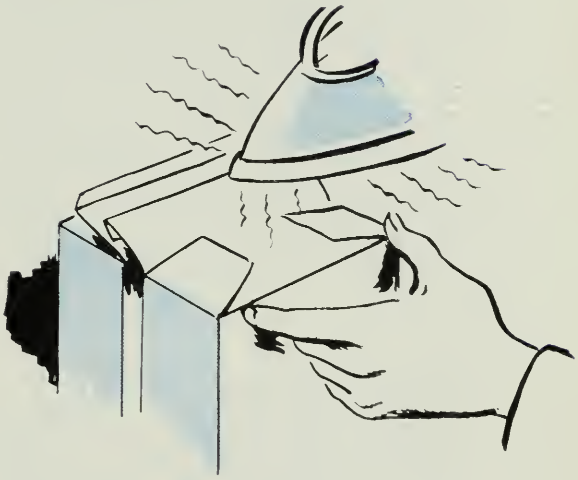
4. Vegetables must be blanched.

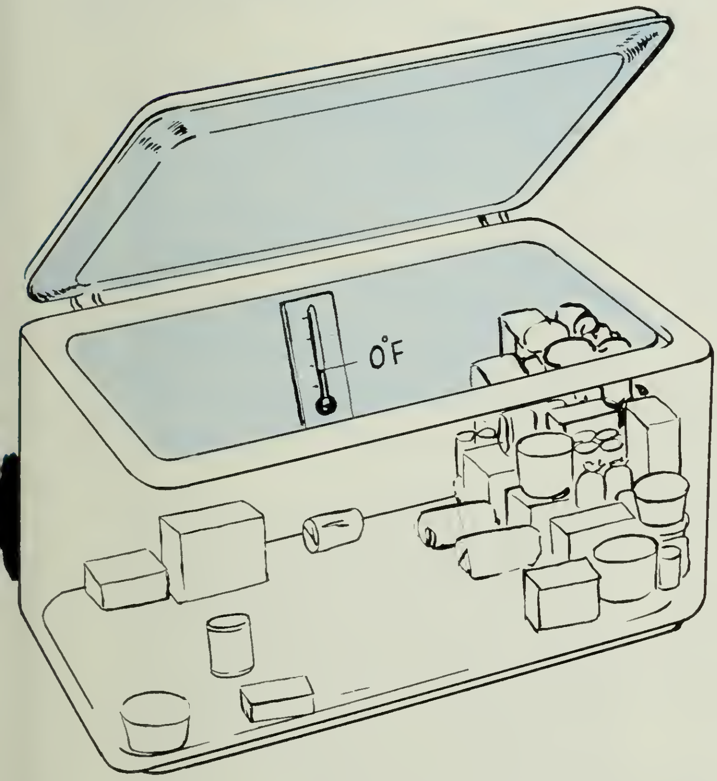
   Count blanching time only when the water returns to a boil.

FOR HIGH QUALITY IN FROZEN VEGETABLES

Cool immediately in cold, preferably running water.

⑤ Seal in MVP packages.





⑥ Freeze immediately and store at 0° F. or colder.

⑦ To cook, place frozen vegetable directly into boiling water (except corn-on-cob).

Less cooking time than fresh vegetables.

Beans, Lima and Horticultural

Harvest when the seeds are green. Wash the pods and remove the seeds. The pods may open more readily if they are blanched and cooled. Blanch the pods 4 minutes, or if the seeds are free of the pods, blanch 3 minutes. Cool and pack. Treat Horticultural beans as limas.

Beets

Young beets are preferred to large, mature beets. Wash the roots thoroughly, cook until tender, and cool. Remove the skin and pack either whole, sliced, or diced. If heated in a minimum of water for serving hot there is little loss of colour.

Tops from young beets make a good frozen product. Select good leaves, wash thoroughly, and blanch 4 minutes (see Spinach). Cool, drain, package, and freeze.

Broccoli

Select dark green, compact heads with sound stalks. Broccoli needs thorough washing and inspection since it is often infested with plant lice or green worms. Soaking the heads for ½ hour in a solution of common table salt (8 tsps. to 1 gal. cold water) loosens the worms. Separate the heads into pieces not thicker than 1 inch. Large stems may be split lengthwise. Blanch small-sized pieces 3 minutes, medium-sized 4 minutes, and large-sized 5 minutes. Cool promptly, drain, and package for freezing. Broccoli may be used as a salad ingredient without cooking.

Brussels Sprouts

Sprouts should be dark green in colour with compact and firm heads. Cut sprouts from main stem. Wash, trim off outer coarse leaves and inspect for green worms. Blanch average size heads 5 minutes. Insufficient blanching results in the development of very obnoxious flavour during storage. Cool, drain, package, and freeze immediately.

Cabbage

Trim off outer coarse leaves. Either shred the head medium to coarse, cut it into wedges, or separate it into leaves. Blanch 1½ minutes. Cool briefly, drain, package, and freeze. Cabbage as a frozen vegetable can be used only in cooked dishes.

Carrots

Young carrots freeze with fair to good quality. Wash thoroughly and scrape. Dice, or slice ¼ inch thick. Small carrots may be left whole. Blanch 3 minutes. Cool, drain, and package.

Carrots and Peas

Prepare each vegetable separately. Then mix in desired proportions, package, and freeze.

Cauliflower

Use firm, compact heads. Trim and cut into serving pieces about 1 inch in thickness. Discard discoloured and insect-injured pieces. Wash thoroughly. Soaking in a salt solution (see Broccoli) to remove worms may be used if necessary. Rinse with water afterwards. Blanch 4 minutes, cool promptly, package, and freeze. Purple varieties change from purple to light green during blanching. Both white and purple types freeze with good quality.

FREEZING CORN

① From a recommended variety, select ears having tender, milky kernels.

② Husk, remove silks, and trim ends.

③ Wash in running water.

④ Blanch for the recommended time (see text).

⑤ Cool immediately in cold, running water.

⑥ For cut corn, slice off the kernels with a knife or special cutting instrument.

⑦ Package cut corn in MVP cartons or poly bags.

⑧ Heat seal the carton liners. Twist and secure the mouth of the poly bag.

⑨ Pack corn-on-cob in poly bags or wrap individual ears in aluminum foil.

⑩ For faster freezing, scatter packages in the freezer (center). When frozen, they may be stacked (left).

Corn — Cut

Special attention must be given to maturity and variety in order to obtain high quality frozen cut corn (and corn-on-the-cob). Select in the field ears that appear ready for table use. Husk and then sort again for the proper maturity. Discard for other uses immature ears (undersized kernels with watery milk) and overmature ears (relatively tough kernels with thick milk that does not spurt out when the kernel is ruptured by the thumb nail).

Remove the silk, wash, and blanch the ears for 4 minutes. Cool, cut the kernels off the cob, package, and freeze.

Corn-on-the-cob

Select ears for freezing as described for cut corn, with the exception that corn-on-the-cob for freezing should be just slightly less mature than cut corn for freezing. Remove the silk carefully, trim the ends, and separate the ears into 3 diameter sizes. Wash in running water. Blanch small diameter ears 7 minutes (e.g. Golden Bantam size), medium sized 9 minutes, and large-eared varieties 11 minutes. Cool thoroughly in water, drain, and package for freezing in poly bags or aluminum foil.

Eggplant

Freezing is probably the only suitable method for long-term preservation of eggplant. The frozen product can be good. It is important that the seeds of the fruits are soft. Best results have been obtained by slicing the fruit into ½ inch slices after peeling. Blanch 2 minutes, cool, and pack. The slices darken during the blanching. The slices may be pan-fried or dipped in batter for frying after partial defrosting.

Kale

Select tender leaves. Wash thoroughly in running cold water. Blanch 4 minutes, cool in running cold water, drain, and package.

Kohlrabi

Select young, tender heads. Peel, dice into ½ inch cubes, blanch 4 minutes, cool, drain, and package.

Mushrooms

Sort into large (1¼″ and up) and small sizes. Wash thoroughly and trim off ends of stems. Large mushrooms may be cut into ¼″ slices. Before blanching dip the mushrooms for 5 minutes into a 1% by weight citric acid solution (dissolve 1 oz. =3½ tablespoons citric acid powder, in 1 pint water). Blanch slices 2 minutes, small-sized mushrooms 3½ minutes, and large 5 minutes. Cool, drain, package, and freeze immediately.

An alternative method, preferred by many people, eliminates the blanching process. Wash the mushrooms lightly to remove grit from the surface. Large mushrooms should be sliced, small left whole. Prepare as for immediate serving by frying in cooking fat, preferably butter. It is important that only small amounts of mushrooms are cooked at a time and that they are removed from the pan as soon as the cooking is complete. Package and freeze immediately.

Okra

The seed pods should be harvested when tender. Wash thoroughly, blanch 2 minutes, cool, pack either whole or sliced. The vegetable is used in soups and stews and it helps to thicken the mixtures as well as flavour them. Its frozen quality is good.

Parsley

Wash, sort, and remove tough, coarse stems. Blanch 15 seconds, cool, drain, and package. The quality of frozen parsley may only be fair, but it is useful in cooking. Chop it while still frozen.

Parsnips

Wash the roots thoroughly. Peel, then dice into ½ inch cubes or split lengthwise into ¾ inch slices. Blanch cubes 1 minute, slices 2 minutes. Cool, drain, package, and freeze.

Peas

Peas make an excellent frozen product. Wash the pods thoroughly before removing the seeds. Blanch the seeds 2 minutes, cool, and package. It is highly important to harvest peas at the proper maturity. Overmaturity results in poor flavour; undermaturity usually results in the skins breaking or wrinkling. Only a few varieties freeze with excellent quality. Peas lose quality rapidly after harvest and must be processed and frozen as quickly as possible.

Pepper

Either green or ripe sweet peppers make a good frozen product. Wash and trim out the seeds, pulp, and stem. They may be frozen in halves or cut into ½ inch strips or slices. Blanch slices 2 minutes, halves 3 minutes. Frozen peppers may be used in the same manner as fresh peppers.

Pumpkin and Winter Squash

These products should be cooked before freezing. Cut into 1 inch cubes, cook until fairly soft, mash or put through sieve, and cool in refrigerator or in a pan floating in cold water. Package and freeze. If a prepared pie mix is frozen, add extra seasoning as it loses its strength during storage.

Rutabagas

Wash, peel, and dice into ½ inch cubes. Blanch 2 minutes, cool thoroughly, package, and freeze immediately.

Spinach

Frozen spinach is a good product. It should be harvested before the blossoms begin to form. Washing the leaves free from sand is always a problem. Knead about 1 pound of leaves in a large pan, or sink, full of cold water. Or, wash carefully in running cold water or spray. Blanch 4 minutes, using at least 2 gallons of rapidly boiling water for each pound of spinach. Push the leaves in the bag or basket into the hot water until they collapse. The sodden mass tends to mat together, so agitate it frequently during blanching. Cool, again avoid matting of the leaves. Drain and gently press out excess water (complete draining is slow and almost impossible). Package and freeze.

Squash, Winter (See Pumpkin)

Squash, Summer

Wash and cut into ½ inch slices. Blanch 4 minutes, cool, package, and freeze. It is not very desirable as a frozen product.

Succotash

Prepare the corn and lima beans separately. Mix just before packaging for freezing.

Swiss Chard

Remove the thick ribs in the leaves and either discard them or process them separately. Blanch 4 minutes as for spinach. Cool, drain, and package.

Tomato Juice

Use well-ripened tomatoes. Wash, remove the stems, and cut into sixths. Simmer for 5 minutes. Separate the juice, using a sieve or strainer with a fine screen. Add salt in the proportion of 1 teaspoonful per quart of juice. Cool rapidly, package, and allow room for expansion during freezing.

RECOMMENDED VARIETIES OF VEGETABLES FOR FREEZING

Asparagus
- Mary Washington
- Viking

Bean, Green Snap
- Blue Lake (Pole)
- Full Green
- Rival
- Tendergreen
- Tenderlong 15
- Topcrop

Bean, Horticultural
- Lowe's Champion

Bean, Lima
- Early Thorogreen (short season districts)
- Emerald Green
- Henderson's Bush
- Limagreen

Bean, Wax
- Brittle Wax
- Puregold Wax

Beet
- Crosby Egyptian
- Detroit Dark Red
- Early Wonder

Broccoli
- De Cicco
- Early Green Sprouting
- Waltham No. 29

Brussels Sprouts
- Catskill
- Half-Dwarf Improved
- Long Island Improved

Cabbage
- Chieftain (Savoy)
- Copenhagen Market
- Danish Ballhead

Carrot
- Nantes
- Red Cored Chantenay
- Touchon

Cauliflower
- Early Snowball
- Snowdrift
- Super Snowball

Corn
- Golden Midget (76*)
- Miniature (78)
- Seneca Chief (85)

Corn
- Hoosier Gold (89)
- Vinegold (90)
- FM Cross (91)
- Victory Golden (101)
- Golden Bantam (102)
- Golden Cross Bantam (103)
- Tendermost (103)
- Calumet (105)

Eggplant
- Black Beauty
- Early Long Purple
- New York Purple

Kale
- Dwarf Blue Scotch
- Dwarf Green Scotch

Kohlrabi
- Purple Vienna
- White Vienna

Okra
- Early Dwarf
- Perkins Mammoth Long Pod

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* Average days to maturity at Guelph.

RECOMMENDED VARIETIES OF VEGETABLES FOR FREEZING (Cont'd)

Parsnip
- Hollow Crown

Peas
- Alderman
- Dark Perfection
- Freezonian
- Laxtons Progress
- Laxton 7
- Thomas Laxton
- Victory Freezer

Pepper
- Early Pimento
- Hungarian Yellow
- Pennwonder
- Vinedale

Pumpkin
- All varieties suitable for making pie

Rutabaga
- Laurentian

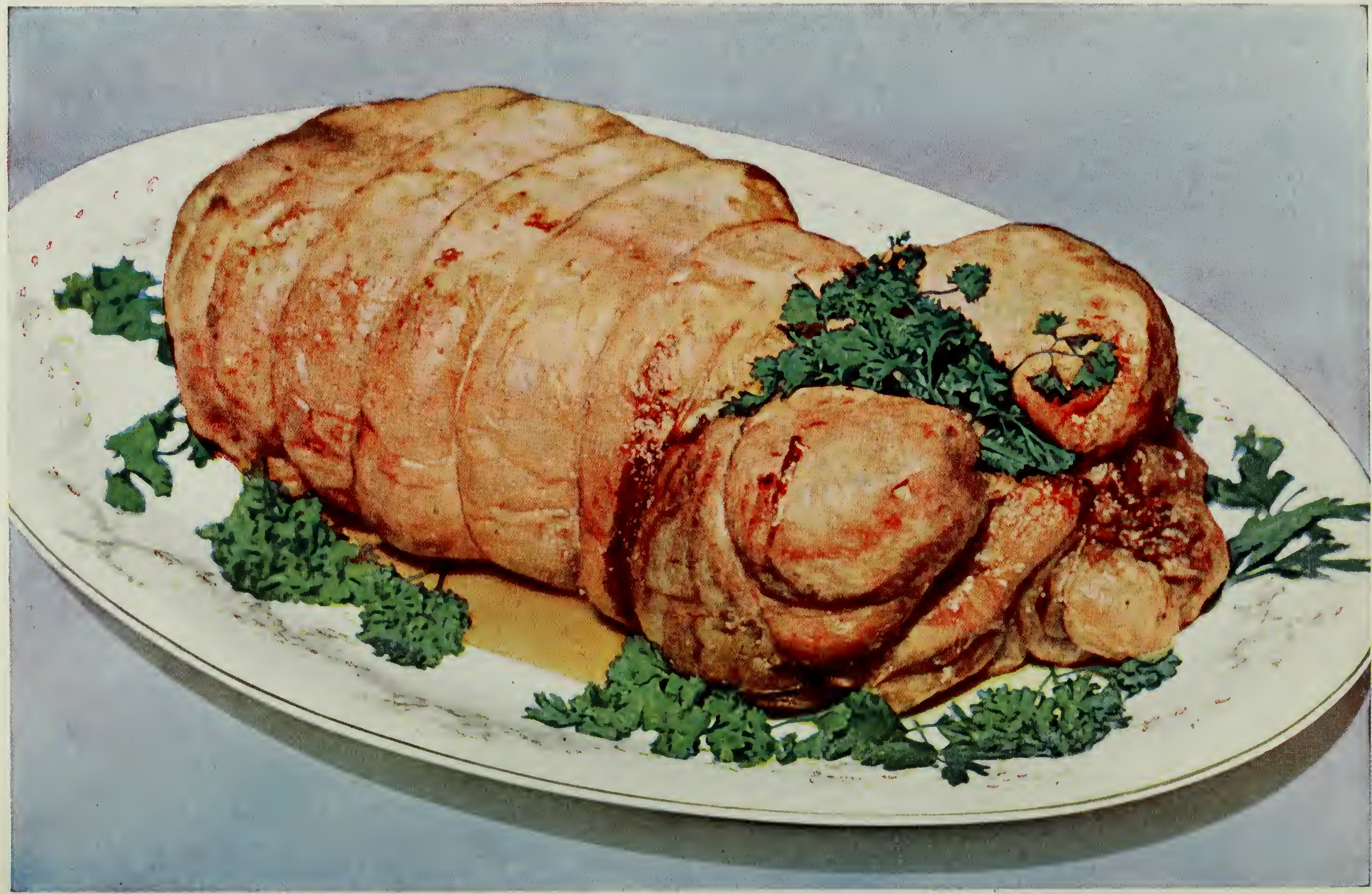
Spinach
- America
- Giant Nobel
- Long Standing Bloomsdale

Squash, Summer
- Cocczelle
- Early Yellow Prolific
- Zucchini

Squash, Winter
- Banana
- Buttercup
- Butternut
- Delicious (Golden and Green)
- Hubbard (Blue, Golden Green and Warted)

Swiss Chard
- Fordhook
- Lucullus
- Ruby

Tomato (for Juice)
- Rutgers
- Long Red



Boned Turkey—a delicacy for that very special occasion. Roasted after storing.

Frozen POULTRY

by E. S. SNYDER

Commercial freezing has long been practised in the preservation of surplus dressed poultry to be held over for consumption during periods of short supply. Unfortunately such poultry, upon removal from storage, was not always of superior quality. Improved methods of processing and handling, along with the development and application of modern freezing methods, have, however, served to greatly improve the quality of frozen poultry.

This has been further helped by the development and wider use of improved wraps and packaging materials which retain the original quality of the product more perfectly and which have made possible packages more convenient in size and shape for storage where space is at a premium. The development and wide distribution of locker plants and the tremendous increase in the use of home freezers and household refrigerators with greater frozen storage space, have greatly stimulated interest in and use of frozen foods. Poultry properly prepared and frozen is excellent in quality and has become recognized as superior in many instances to so-called fresh-killed stock. It is, therefore, not surprising that poultry has become one of the most popular products for freezing and storage in home freezers wherever such facilities are available.

All kinds of poultry can be successfully frozen, the more popular being boiling fowl, roasting chickens, turkeys, ducks and geese.

If recommended methods are followed in the selection of quality, preparation, packaging and freezing, frozen poultry is one of the most successfully frozen foods.

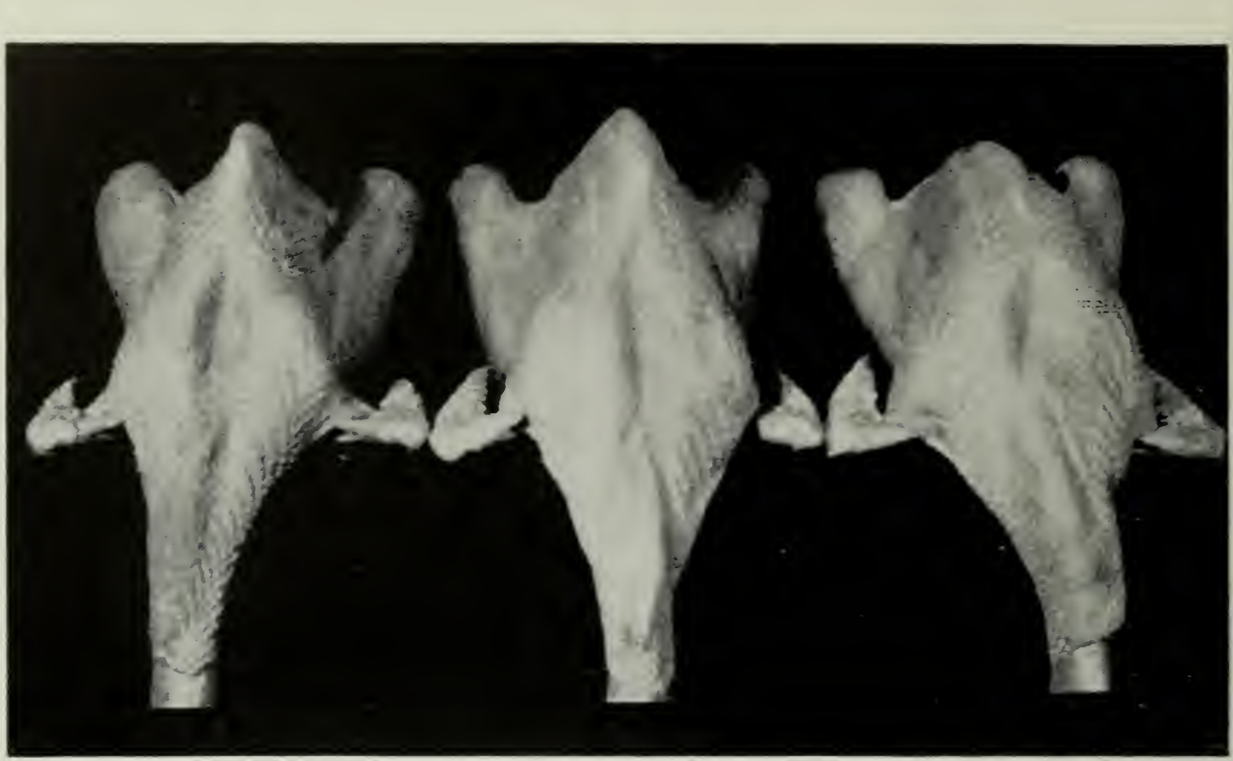
SELECTION OF POULTRY FOR FREEZING

Eating quality of frozen poultry depends upon the quality of the bird when slaughtered; also on immediate and rapid cooling to below 40° F. following slaughter. For the housewife, evisceration and further processing is most easily done after cooling. Commercially, most poultry is now eviscerated hot, then quickly chilled. In either case, quick evisceration prevents development of unpleasant odours and flavours from the presence of intestinal contents within the birds.

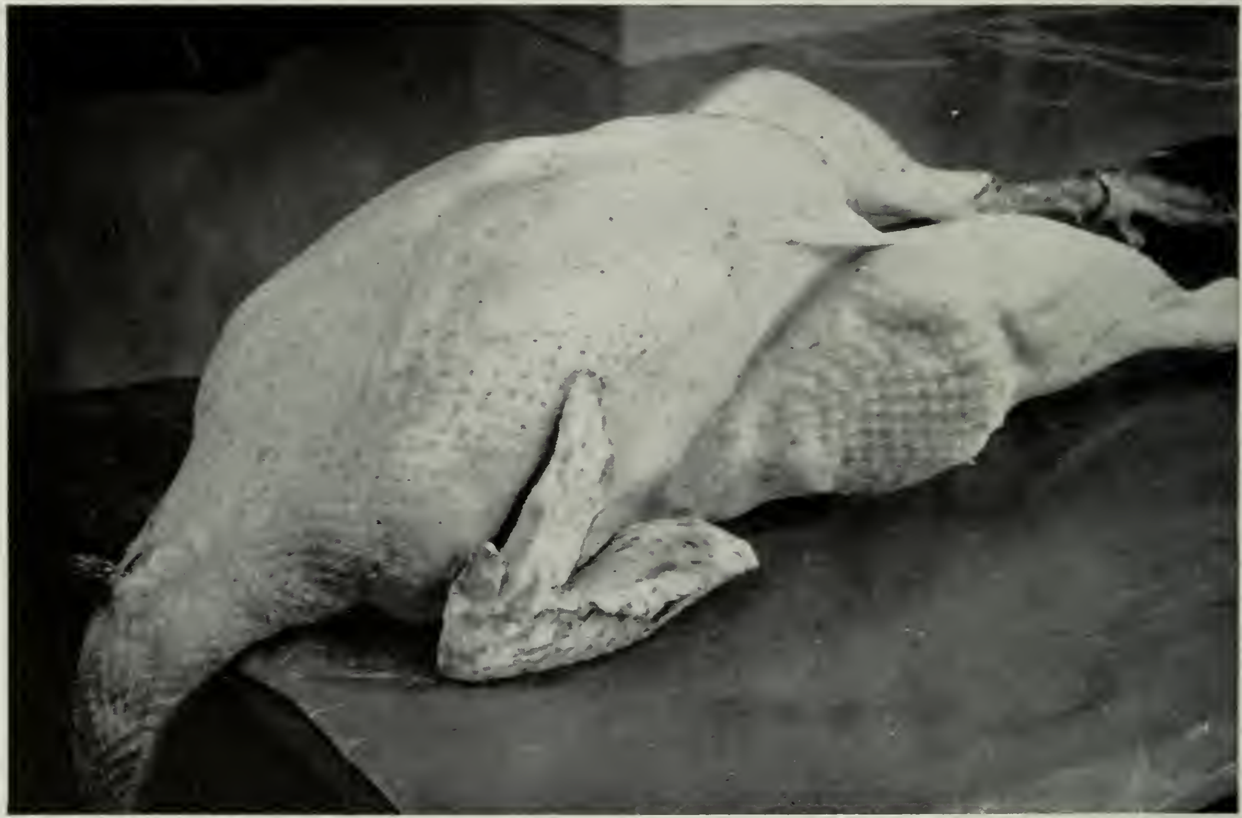
In selecting poultry of any kind for freezing, preference should be given to grade Special, grade A and the better grade B birds graded according to Canadian Dressed Poultry Standards. (While freezing may have a slight tenderizing effect on the flesh, the effect is not so great as to change boiling fowl, stags and old turkeys, geese or ducks to the tenderness of young birds.)

Chicken—Birds of the above quality will be compact in body, well-fleshed in breast, thighs, drumsticks and back. They will carry at least a moderate amount of internal and skin fat and will be straight-breasted and free from tears, blemishes, abrasions and discolourations.

Turkey—Birds of the broad-breasted type carrying a moderate amount of fat are most satisfactory. They, like chickens, should be well dressed, free



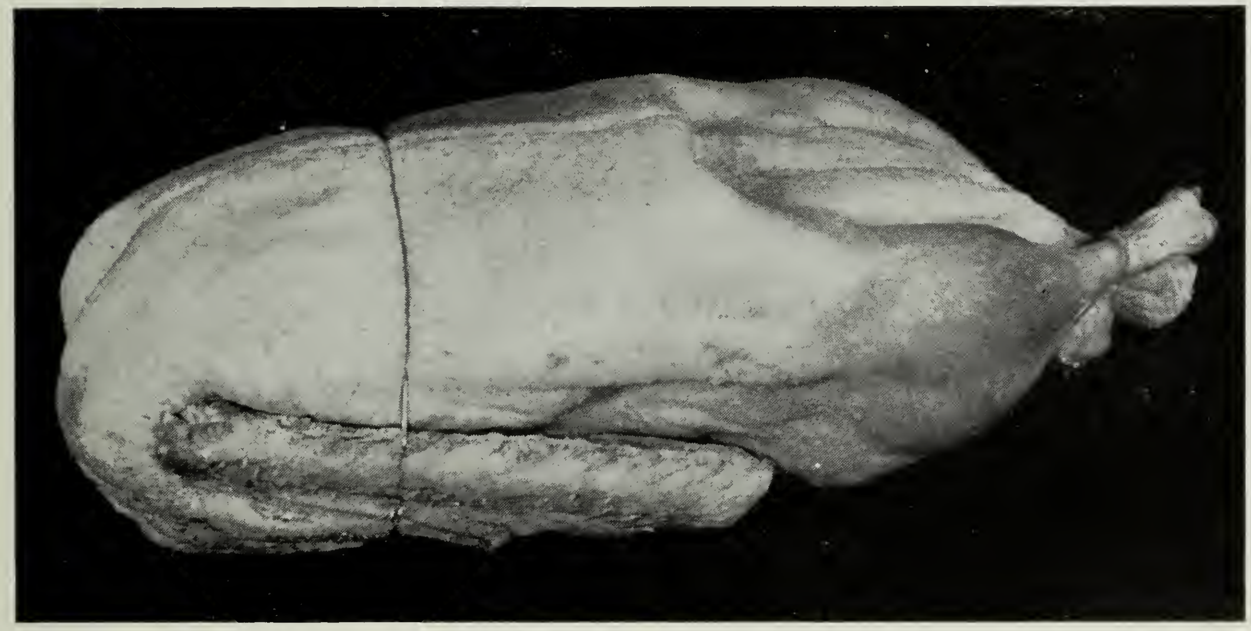
From right to left, typical A, B and C grade fowls, illustrating the desirable type, fleshing and finish of Grade A as compared with the less desirable Grades B and C.



A grade Special turkey carcass, showing the wealth of fleshing, fine finish, and attractive appearance common to top grade birds.

from discolouration and show plenty of bloom. Small to medium-sized turkeys are frozen whole.

A half turkey. An excellent way of preparing a large turkey for freezing; or the bird may be drawn and frozen—then sawn into halves or quarters as desired.



A well-dressed Grade A goose carcass, drawn and ready for wrapping, in preparation for freezing.

Large turkeys may also be frozen whole or they may be drawn, then cut in half or quartered for use according to the size of the family or number of persons to be served at one time. In this way large turkeys, because of their lower price per pound, are economical as compared with the higher priced but more popular smaller birds.

Turkeys may also be cut up and frozen in convenient-sized pieces such as wings, thighs and drumsticks, and in rolls made from a half breast or a half breast and a thigh rolled and tied together.

Turkey—whole, halves, quarters, boneless rolled-breast, thighs, wings, drumsticks, giblets—plastic packed, ready to be frozen.

Duck—Preference is given to broad-breasted, deep-fleshed birds, moderately fat but not excessively so.

Goose—The above is also true of geese, where depth of breast fleshing is desirable rather than excessive fatness. Ducks and geese should be well dressed and free from severe skin damage caused by excessive or poor scalding.

Other Fowls—Guinea fowl, squab and game birds will also freeze satisfactorily if well fattened, cleanly dressed and quickly chilled after dressing, then frozen.

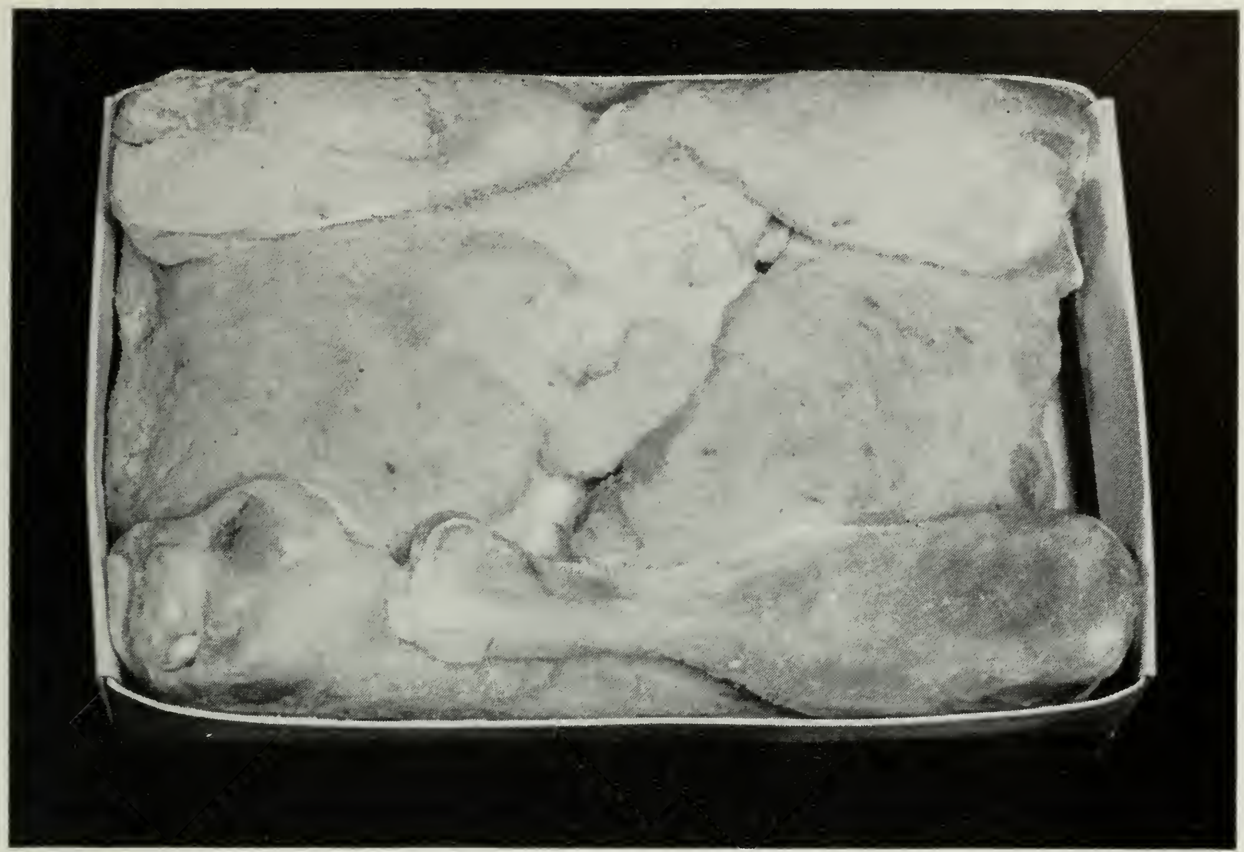
Thin, poor quality fowls of any kind are not desirable for freezing.

PREPARATION OF POULTRY FOR FREEZING

Householders will find it advantageous to purchase, for freezing purposes, poultry either New York dressed or better still, poultry fully eviscerated. Few householders have either the facilities or the skill to slaughter and dress poultry properly. New York dressed poultry (blood and feathers removed) is readily obtainable directly from farmers, at farmers' markets and from any poultry dressing plant. Many of these also supply fully eviscerated stock (ready-to-cook). The latter are preferable as they are more easily prepared for freezing.

Whether purchased eviscerated or New York dressed, it is very important, for best results, that all such poultry be freshly killed and that it has been quickly chilled to below 40° F. and held at such temperature until packaged — then sharp frozen.

Singeing—Unless already done when purchased, all birds should be singed before packaging. This removes all down and/or hair-like feathers. Use of a gas or other smokeless flame will prevent blackening of the skin. A blowtorch



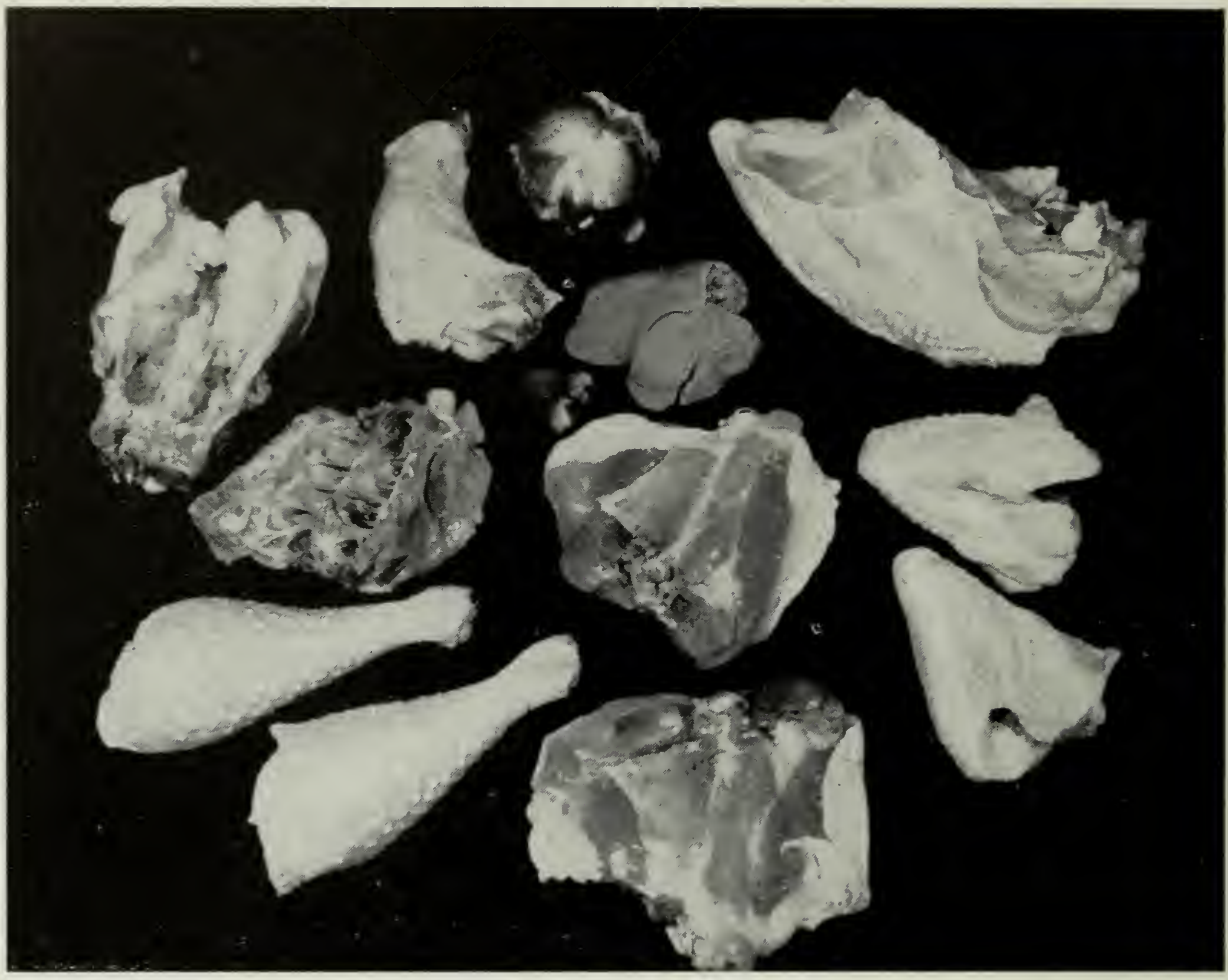
A fryer cut-up ready for the pan, packaged and frozen.

will serve well if available, but excessive heat is to be avoided because of resultant skin injury and damaged appearance.

Eviscerating—Whether to eviscerate (draw or clean) fowls before freezing is still a point of argument on the part of some. Most housewives will, however, find it more convenient to freeze only fully eviscerated birds. While such fowls require special wrapping to adequately protect cut surfaces, leaving the viscera in birds affords considerable chance of visceral taints entering the flesh. Even more important, perhaps, is the difficulty experienced in removing frozen viscera and also the delay necessary to thaw them when, on short notice, a fowl is required for the table.

Several methods may be used in eviscerating fowls; through either a vertical or horizontal incision at the rear, or by splitting the bird up the back on one side of the backbone. In any case it is best to remove the neck by splitting the skin along the back of the neck to the shoulder and then severing the neck at this point. This is then wrapped in a package with the giblets. Removal of the neck makes easy the removal of the crop and trachea (windpipe). To eviscerate from the rear, an incision is then made in the abdomen from the end of the breast to the vent, which is then encircled, thus freeing the intestine. The viscera are removed through this opening. Or, the incision is made horizontally across the abdomen just behind the end of the breast bone. Then a second incision is made encircling the vent, thus freeing the intestine and allowing the viscera to be removed through the horizontal incision.

To eviscerate by splitting up the back, the skin is first slit open from shoulder to tail along the right side of the backbone. A stout kitchen shears or a small-sized tinsmith's shears will serve to cut along this line from tail



A cut-up fowl showing the methods of cutting for stew, chicken pie, etc.

to shoulder. A short-bladed heavy knife or a linoleum knife will serve equally well. A knife-cut from the tailhead to and encircling the vent, makes possible the spreading apart of the severed bird for easy removal of the viscera, including lungs and kidneys. The oil gland on top of the tail should also be carefully cut out and removed.

Whichever method is used, the lungs and kidneys should be completely removed and the eviscerated fowl well washed in cold water; then hung or set on end to thoroughly drain before wrapping.

The giblets — heart, liver and gizzard — may be cleaned, washed and, along with the neck, wrapped in cellophane or waxed paper and inserted into the body cavity. Livers are best used fresh as they do not keep particularly well frozen.

Trussing—Trussing improves appearance and results in a more compact bird for packaging. The neck skin is drawn well down over the back and, along with the wings, may be tied tightly to the fowl's body. In the split bird this neck skin serves to cover a considerable portion of the cut. The legs are then tied firmly to the tailhead. Birds eviscerated by means of a vertical incision are trussed in the same manner, with legs tied firmly to the tailhead.

When the horizontal incision is used, the legs may be inserted into this incision and out through the opening made for removal of the vent. This serves to hold them tightly without tying, and is the method quite commonly

Goose wrapped in cellophane, on a cradle used to prevent skin injury while wrapping. For a longer than two months' period of storage, a heavier plastic—more durable under low temperature—will give better protection of both flavour and appearance.

used in trussing fowl, chickens, capons and turkeys. The legs of waterfowl are too short, so are usually tied together to the tailhead.

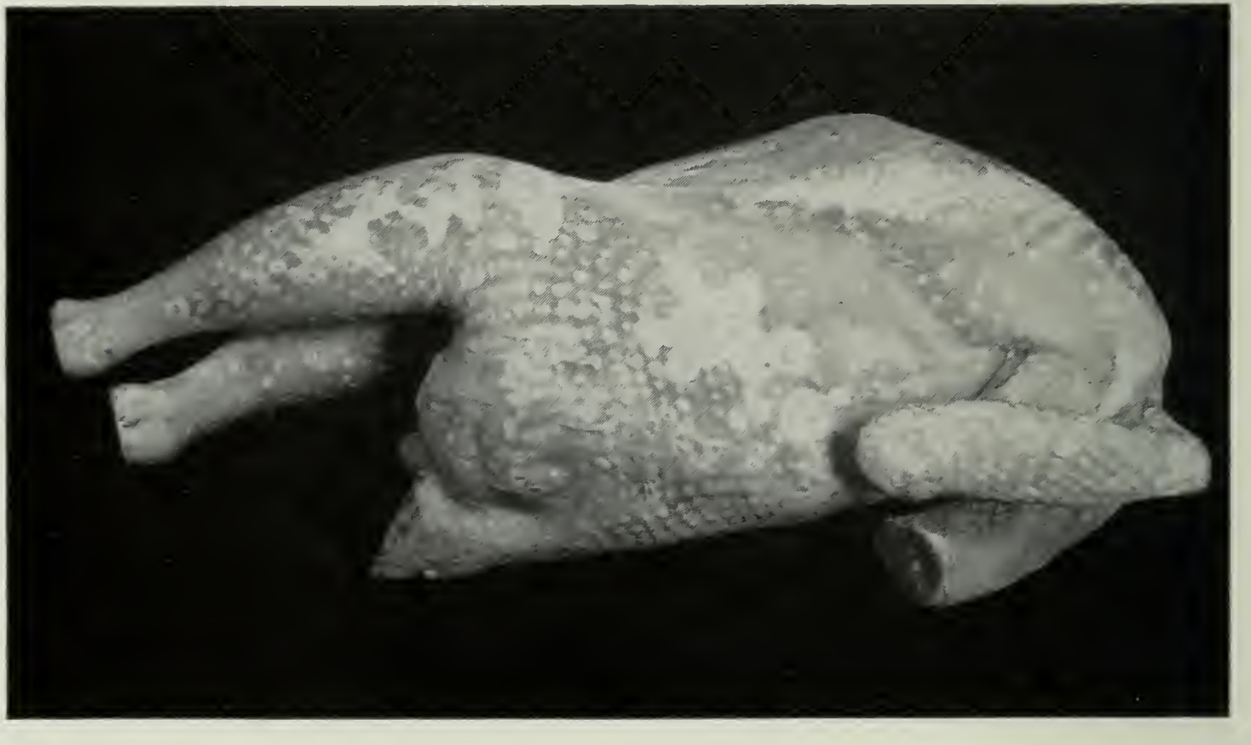
Stuffing—Some housewifes find it convenient to have roasting chickens and even turkeys stuffed before freezing, using for the purpose a favourite stuffing mixture. Unless considerable care is taken to keep both fowl and stuffing cold and to have the stuffed fowl quickly frozen, this may be a dangerous practice. Bacterial development may be rapid in warm stuffing mixtures and may continue at reduced rate even during subsequent freezing and thawing. This may result in food poisoning.

If stuffing is practised, great care should be taken to make up the mixture quickly, to practise utmost sanitation and to freeze the stuffed fowls as rapidly as possible. It is also good practice to place such birds in the oven for cooking, while still frozen. Where such precautions are taken, stuffed birds are a very real convenience when roast chicken or turkey is required on short notice.

Several kinds of stuffing may be used. In experiments conducted cooperatively by the writer and Dr. J. H. L. Truscott, it was found that stuffing mixtures made up of any of the following ingredients proved reasonably good during a storage period up to thirteen months: bread crumbs, mashed potatoes, a moderate amount of onion, chicken fat, sage, dried fruit and salt.

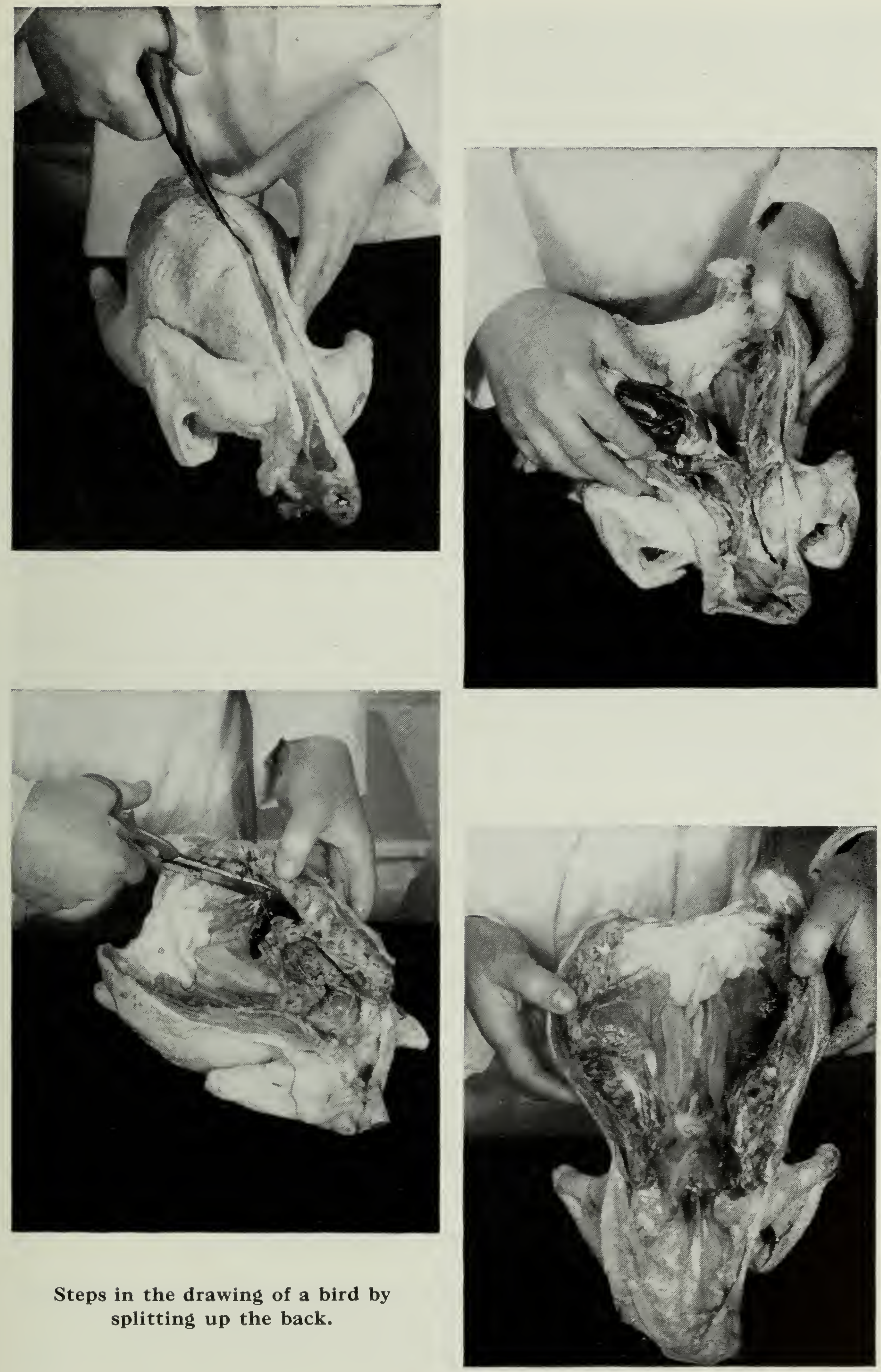
It is important to stuff birds loosely, as otherwise the dressing will come out soggy.

Cellophane-wrapped goose covered with stockinette to protect the cellophane from tears during handling and storage in freezer.

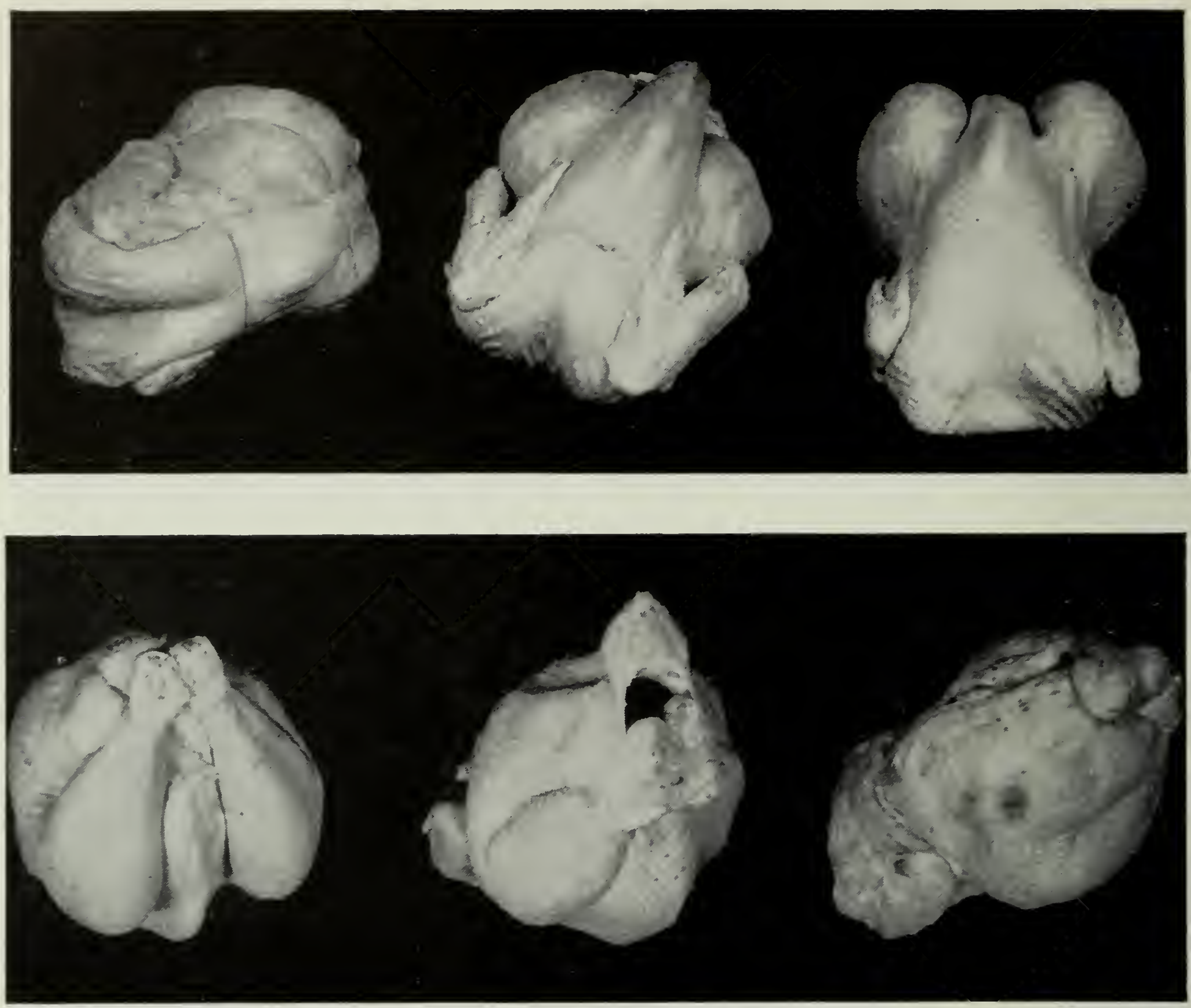


Chicken, showing moderate freezer-burn.

Unfortunately some ingredients used commonly do not retain good quality when frozen. Our work indicates that pork sausage meat, chopped peanut and onion may give trouble. Pork sausage meat after 4 months of storage at 0° F. was quite inedible. Peanut in a dressing was rancid after 4 months' storage; an onion flavour at the same time was too intense and somewhat off in flavour. Unexpectedly, all of the above ingredients improved with longer storage. After 13 months of storage, rancidity had disappeared from the nut stuffing mix, the onion flavour was nearly normal and the sausage meat was less offensive but still not palatable.



Steps in the drawing of a bird by splitting up the back.



Front and rear views of three birds, illustrating the three described methods of eviscerating. Left to right, split up the back, horizontal incision, vertical incision.

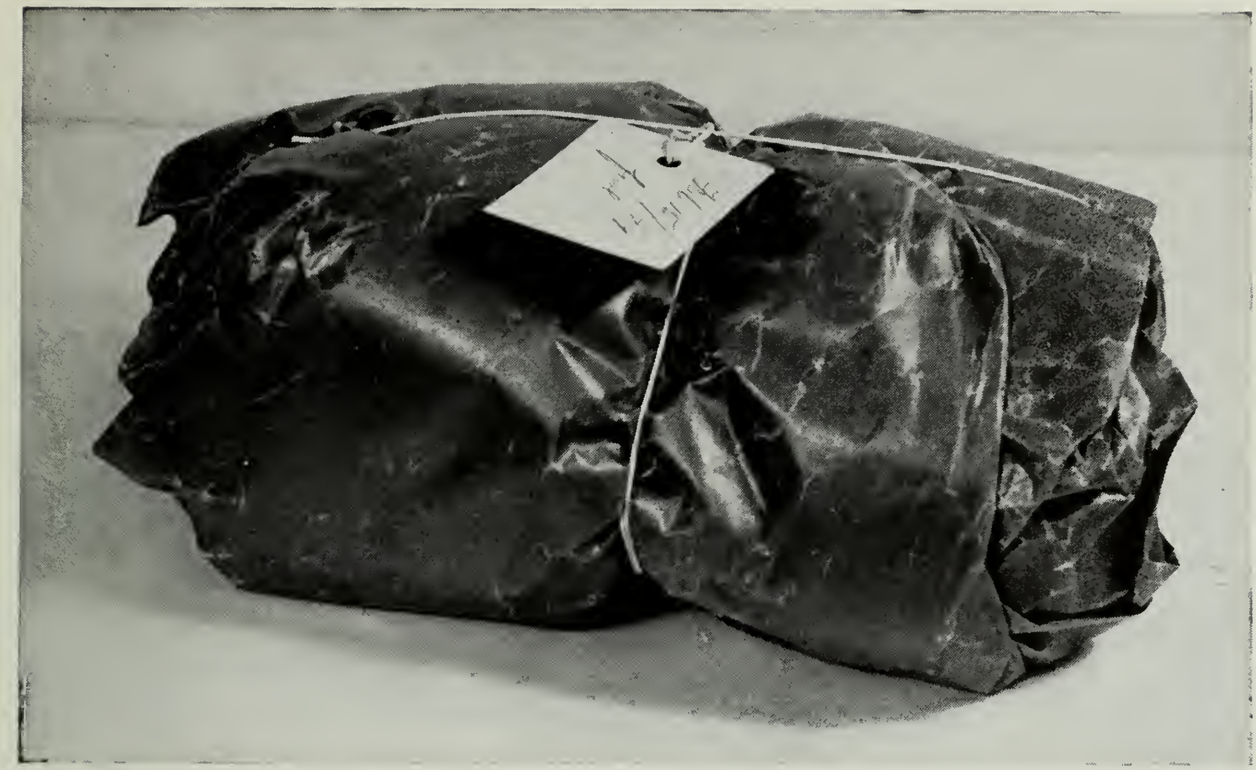
Most flavouring ingredients such as sage, were normal in flavour but the amount of flavour became less as the storage period increased.

It is suggested that a favourite mixture be tasted in one or two birds after the stuffed birds have been in storage for 3 or 4 months. Even though the stuffing does not prove satisfactory, there is little loss since the flesh of the bird is not likely to be affected.

Fryers and Broilers—Considerable space is conserved in the freezer if broilers and fryers are cut into serving pieces before freezing. Larger birds can also be halved or cut into smaller pieces before freezing. This is an effective space-saver with boiling fowl intended for pie or stew. Turkeys, turkey broilers and roasting chickens may also be cut up for convenience in use and to safe space in the freezer.

PACKAGING OR WRAPPING

Good packaging or wrapping is necessary if frozen poultry is to retain good quality. Cut-up birds offer relatively little difficulty because the parts can be fitted tightly into rectangular packages of waxed cardboard which, in turn, can be readily wrapped in a suitable foil, film or waxed paper. Whole birds



Fairly satisfactory results follow close double-wrapping of a fowl with a good wax-coated paper.

A turkey carcass prepared ready-to-cook and packaged in an air-tight Cry-O-Vac bag from which the air has been extracted and made form-fitting by momentary immersion in water just under boiling temperature.

packaged singly are difficult to wrap effectively because of their uneven shape.

Effective packaging is necessary for several reasons: to keep the birds clean, to prevent contaminating flavours reaching them, and to prevent or reduce freezer-burn.

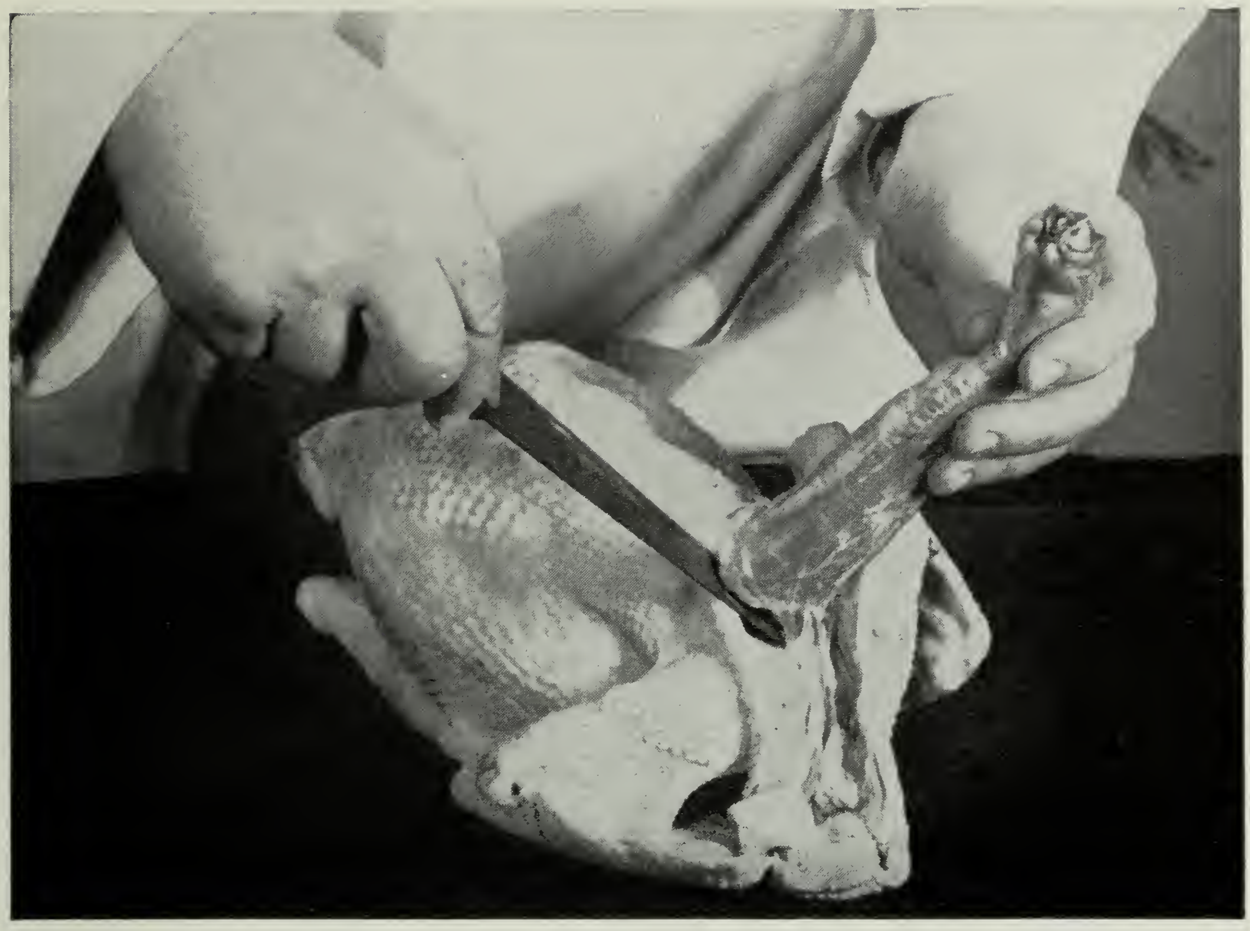
A turkey carcass prepared ready-to-cook and packaged in a plastic tubing ready for freezing. Air has been extracted and the ends folded over and tied.

Freezer-burn is the name given to whitened areas surrounding the holes in the skin from which feathers were drawn. Excessive freezer-burn will cause the white patches to get larger to the point where they join into large unsightly masses. Moderate to slight freezer-burn may occur on even well-packaged birds and it does not appear to affect the flavour of the flesh. Moreover, it disappears during cooking. More severe freezer-burn results in impairment of flavour and texture or excessive weight loss from the birds. It is caused by the evaporation of water from the bird. Drawn birds are especially affected since more tissue is exposed.

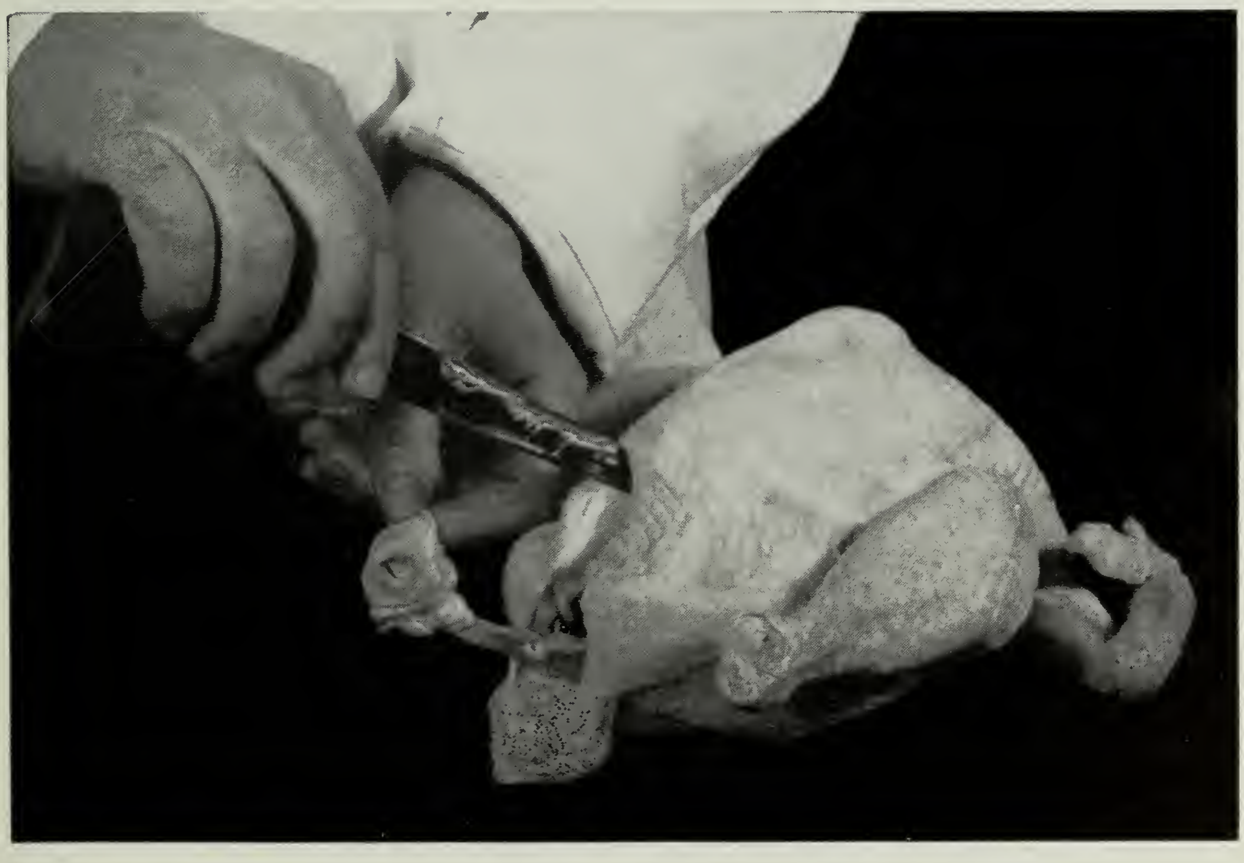
For short holding periods, up to three months or so, close double-wrapping with a good wax-coated locker paper will supply fairly good protection, though birds so wrapped may undergo some desiccation and show some freezer-burn. Even ordinary "butcher" paper will prove considerably better than no wrap at all. Cellophane may also be used for short holds; also aluminum foil. Reference should be made to Packaging in the introductory section.

The most protection and best results follow the use of a vacuum pack in an air-tight, vapour-proof shrinkable type of plastic bag known as Cry-O-Vac. Polyethylene bags, though non-shrinkable, also serve well and are less costly. Supplies of wrapping materials of various kinds and sizes may usually be procured from a local locker plant operator.

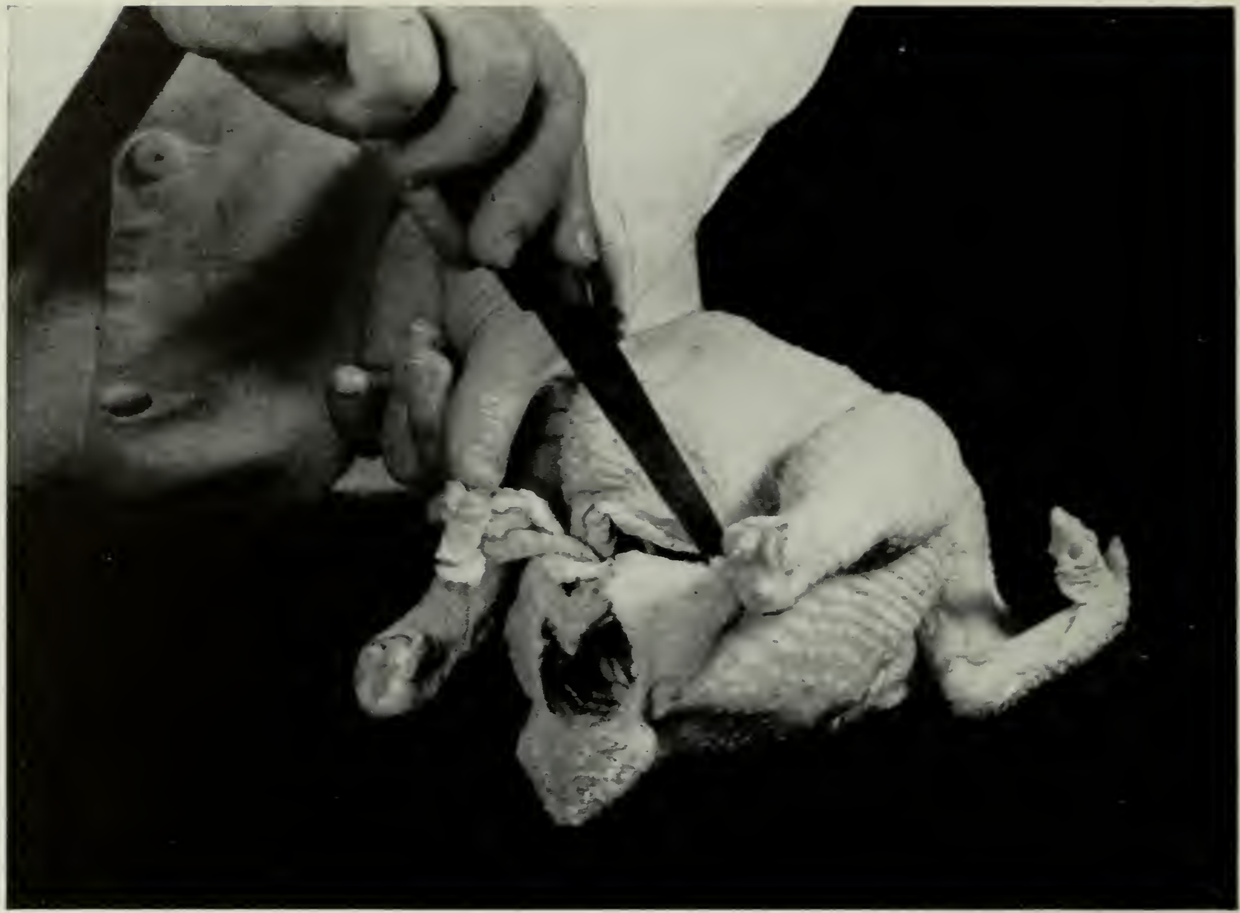
To cry-o-vac any fowl requires the same procedure, whether broiler, roaster, turkey or waterfowl. The eviscerated fowl, with neck removed and wrapped giblets inside, as already described, is trussed and placed in a bag of suitable size. The air is then exhausted by means of a vacuum created by a vacuum cleaner, an asperator such as is used to empty a washing machine, or a regular vacuum pump made for the purpose. The open mouth of the bag is tightly



The first step in drawing—removing the neck.



Circling of vent and vertical incision for removal of viscera.



Circling of vent followed by horizontal incision.

held over the vacuum tube of whichever piece of equipment is available. When all possible air has been extracted, the neck of the bag is tightly twisted to close it. It is then tied off with a string, special rubber band or metal clip available for this purpose. Dipping the packaged bird into near-boiling water, or pouring boiling water over it from the spout of a teakettle will shrink the bag to skin-tightness. It is then ready to be quickly frozen. Poultry of various kinds so packaged and frozen has shown no freezer-burn after two to even three years of storage, no appreciable shrink and little, if any, depreciation in flavour when cooked.

With either Cry-O-Vac or polyethylene bags one can do a fair job, even without a vacuum pump, by simply submerging the bagged fowl in water to press out as much air as possible, then closing and tying as already described.

Regardless of the wrapping used, it is essential that great care be exercised to leave as little air space as possible around the carcass and to see that all joints in the wrap are sealed by foldings or other means.

Cut-up birds are most conveniently packed in rectangular, waxed cardboard containers. (See page 39.) It is preferable to use an inner lining of foil or film, and seal the outside of the box with an overwrap of suitable material. Or, the parts may be packaged in plastic bags as shown on page 38.

FREEZING

Poultry should be cooled in air for about 24 hours at from 32° to 34° F. or in cracked ice until thoroughly chilled, before packaging and freezing. Most

Scene on a small farm processing plant. Capon being vacuum-packaged and others on rack ready to be moved to the sharp freezer. The wash boiler contains hot water for shrinking the packaged birds.

people do not like the flavour changes resulting from hanging birds to age the meat. Following packaging, the birds should be frozen as quickly as possible. The chief importance of quick freezing in poultry is that an arrangement that provides quicker freezing automatically gives quicker cooling. It is important that the temperature of the bird be reduced so quickly that moulds have no chance to develop. A well-wrapped roasting chicken may require 24 to 48 hours to freeze to the centre in a blast of 0° F. air. If several birds are piled together the freezing time is increased. Most of the birds sent here for examination because of unsatisfactory condition, have been affected by mould growth. In most instances the mould must have grown in the interval between packaging and freezing.

Locker plants are required to have sharp freezing facilities at −10° F. or lower and storage room temperature of 0° F. Some processing plants freeze at −20° to −50° F. Those using home freezers should place the birds in contact with a cold surface in the box. The holding temperature should not be above 0° F., partially because there are likely to be other foods in the box that must be held at 0° F. or lower. Even with poultry, however, a group of persons here were unable to distinguish flavour differences between

Whole eggs, yolks and whites, may be successfully frozen if first slightly beaten. Whole yolks tend to partially solidify. Left to right, whole eggs beaten, whole egg, egg yolks beaten, egg-white whole.

chickens held for 13 months at 10° F. and those held at 0° F. for the same length of time. There was no detectable depreciation of flavour in chickens held 13 months at 0° F. However, lower temperatures are safer and should be used wherever possible.

COOKING FROZEN POULTRY

There is some difference of opinion as to whether poultry should be thawed before cooking. Obviously an undrawn bird must be at least partially thawed before the viscera can be removed, or a drawn bird may require some thawing before it can be stuffed. If, however, a bird is ready for the oven, or if cut-up pieces are to be fried, broiled or boiled, cooking can commence when the flesh is frozen. According to our experiments the cooked flesh was indistinguishable regardless of whether the flesh was thawed or frozen when cooking began. It may be necessary to increase the cooking time somewhat when starting with frozen flesh. A thawed bird may be slightly more susceptible to bacterial attack than a fresh-killed bird but there isn't an important difference from the housewife's standpoint. It is always good practice to handle both thawed and so-called "fresh" birds quickly as both are very perishable.

Poultry may be cooked before freezing. The flesh kept in excellent condition for 13 months at 0° F. according to our observations. Stuffing mixtures behaved in a manner similar to that in uncooked birds (see section on Stuffing).

MISCELLANEOUS POULTRY PRODUCTS

Chicken a la King and **Chicken Pie**—Chicken and turkey preparations such as Chicken or Turkey a la King may be successfully frozen. Tastes vary greatly. It is suggested that the housewife test favourite preparations at intervals after freezing to ascertain their keeping quality. It is, however, not usually advisable to attempt holding such preparations longer than from three to four months. The meat used should be well cooked and may be either shredded or diced. Many prefer the latter. If desirable, vegetables, such as peas, diced carrots and mushrooms may be added, along with gravy, and the whole seasoned to taste. A tightly crimped pie crust is desirable and excessive liquid in the filling is to be avoided. Experience has taught the importance of utmost sanitation and speed in the preparation of ingredients and mixtures. Broth and gravy especially are excellent media for bacterial development and, consequently, sour quickly. The practice of sanitation, rapid cooling and quick freezing in the making of such pies will result in a safe, delicious and satisfying product. Mature fowls such as stewing chickens, roasters and breeder turkeys — because of their more pronounced flavour — are particularly desirable for use in pies.

Turkey "Steaks"—There has been some interest in turkey meat prepared by machines that form pieces of meat into shaped flat "steaks." These may be of either white or dark meat and are usually 4 ozs. in size with a little fat included for flavour. Considerable attention to sanitation is advisable in their preparation and each steak is best enclosed in a small heat-sealed, cellophane bag. After immediate freezing, a number of steaks may be packed in a suitable container for further storage.

Sliced Roast Turkey—Sliced roasted turkey meat may be satisfactorily frozen, when fresh, and held for periods up to a month or two. These slices can be quickly defrosted and made into delicious roast turkey sandwiches at a moment's notice when friends drop in for an evening. Slices of white meat are particularly nice. The slices should be cut fairly thick and should be placed on a piece of smooth surfaced cardboard to prevent them curling or breaking. Close wrapping with cellophane or placing in a cellophane bag and heat-sealing is required. Enough meat (about 4 ozs.) for four persons may be placed in each package. Roasted smoked turkey is particularly nice prepared in this way. Some butchers are equipped to smoke turkeys. Sliced roasted turkey meat will tend to become dry and tasteless if held too long — more than one or two months.

Diced Turkey Meat—Left-over roast turkey or chicken meat may be diced, placed in cellophane bags and frozen for future use in making turkey or chicken a la king and salad. Just enough for use at one time should be placed in each heat-sealed bag.

Giblets—Chicken hearts, livers and gizzards in appropriate packages remained in excellent condition for 13 months at 0° F.

Eggs—Egg shells crack when whole eggs are frozen and the yolks become gummy and partly solid. Separated egg white may be frozen in such containers as paper cups. Yolks or mixtures of yolk and white should have about a tablespoon of syrup or sugar stirred into each 2 cups of mixed egg. The mixture may then be divided into paper cups in the quantity needed for a cake, etc.

Choice cuts of Beef for the freezer.

Frozen MEATS

by E. C. STILLWELL

Freezing meats under controlled methods of modern refrigeration is a great convenience. This is very evident in country districts remote from retail meat markets and also at certain times of the year when the natural temperature forbids the slaughtering of animals unless mechanical refrigeration is available. The use of freezing storage has added greatly to the variety of the meat diet in many homes, as well as keeping the family budget down.

KINDS OF MEAT

Beef, pork, lamb and veal are the meats most commonly frozen, although at certain seasons of the year game may be added to the diet. It is well to avoid extremes in finish, that is, meat from animals which are too fat, as the fat oxidizes and rancid flavours result, and if the fat is trimmed off it adds to the cost. Meat from very thin animals might be so lacking in fat that it would lack flavour and palatability. Carcasses from healthy meat producing animals, in a reasonable degree of finish, are preferable to those from non-meat producing and in poor flesh. Beef and pork are at the top of the list in kinds of meat frozen.

PREPARATION

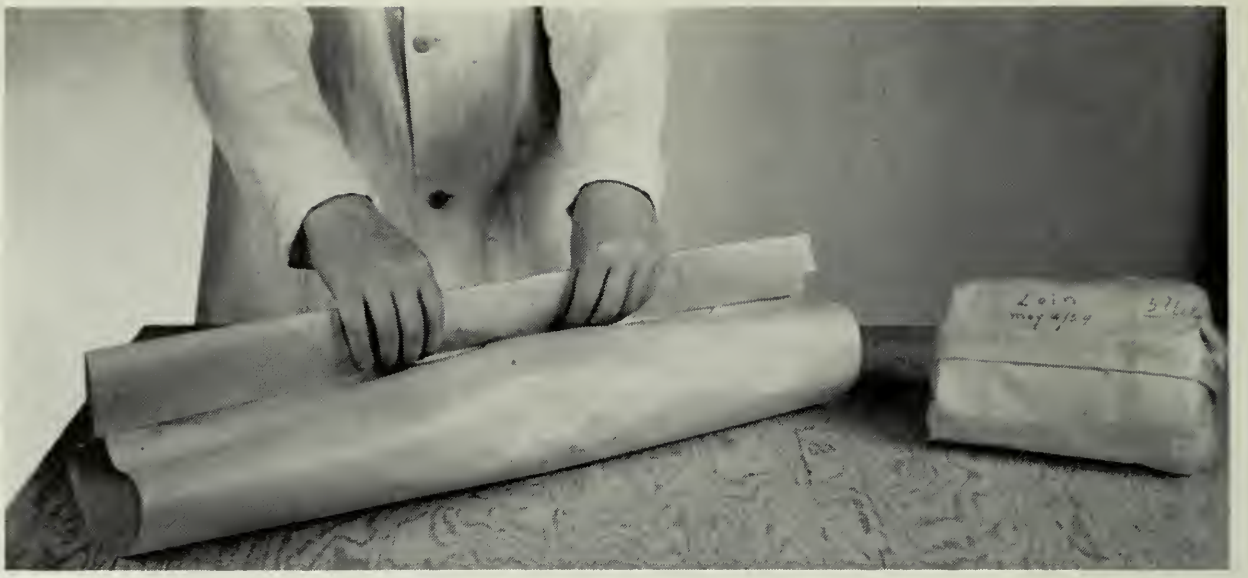
Animals, for meat, may be slaughtered on the farm or, if the facilities are available, at the storage plant. Feed should be withheld from the animals for eighteen to twenty-four hours before slaughtering, but water should be available. A quick job of killing and a clean job of dressing should be the main points to remember.

COOLING

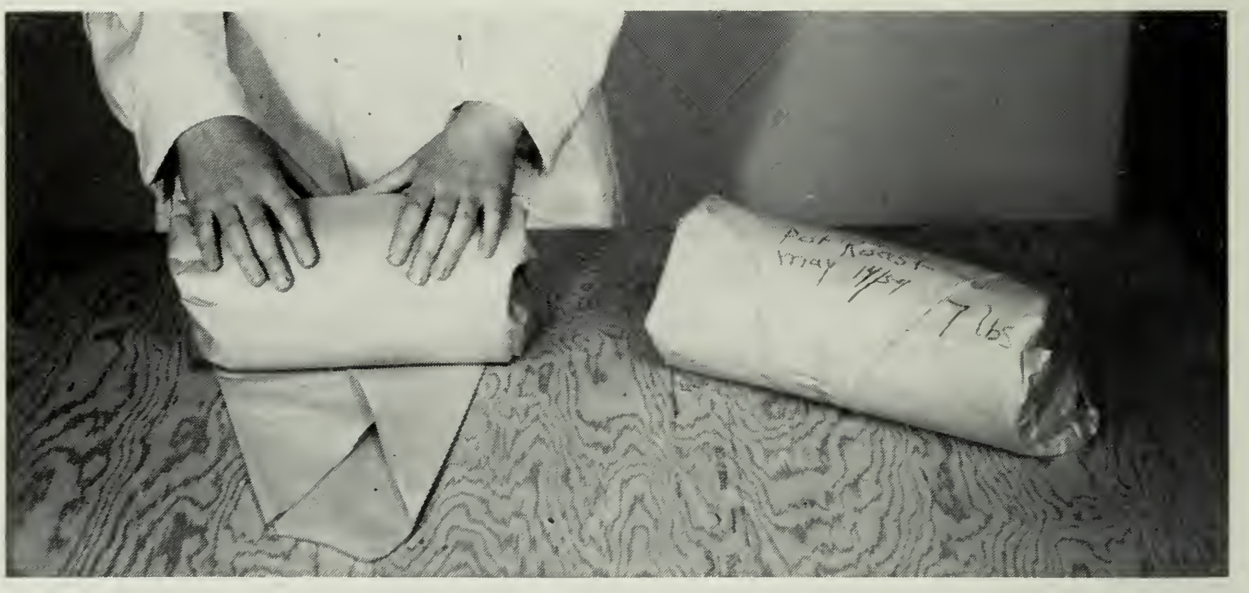
Carcasses which are properly cooled are much easier to cut because they are firm. Soft flabby meat which has not been properly chilled will result in ragged unsightly cuts. The ideal temperatures for cooling should be between 33° F. and 38° F. If temperatures cannot be controlled the animals may be killed in the evening and get the benefit of the cold night air provided it does not go below the freezing point. In extremely cold weather carcasses should be hung in a sheltered place to avoid freezing. In any case carcasses should be properly cooled out before cutting.

RIPENING

It is not necessary to ripen carcasses from young animals, that is approximately one year old. Meat from older animals if held at temperatures 33° F. to 38° F. for two weeks will break down the tissues and make the meat more tender. It is true, freezing also has a tendency to tenderize. If the meat is held for too long a time, the outside of the carcass becomes discoloured and mouldy; this will have to be trimmed, which adds to costs. Baby beef and lamb require very little ripening. The following time-table is suggested for ripening or holding carcasses:



Drug-store method of wrapping meat.



Butcher method of wrapping meat.

Meat packaged in Cry-O-Vac bag.

Beef —	good and choice	2 weeks
	medium and common	1 week
Lamb —	good and choice	1 week
Pork		3 to 4 days
Veal		24 hours

CUTTING

The cutting of meat varies with the storage plants. Some processors cut to suit the wishes of the customers, others have one method and follow this only.

There is the retail style, giving a large number of steaks and roasts.

There is the system of cutting to suit the wishes of the consumer.

Possibly the most important point to keep in mind is to cut into pieces to suit the size of the family.

In many plants the electric meat cutter or power saw is a necessity to keep costs down to a minimum. Considerable care must be exercised by the operator of the saw to get best results. Too often a good saw is ruined and then condemned by an unskilled operator. Another point that needs attention is cleanliness. A good operator will take pride not only in his workmanship but in keeping the machine clean.

BONING AND ROLLING

The boning and rolling of meat has many advantages:

1. Conserves space in the locker, a saving generally of 25 per cent but 50 per cent in the case of lamb.
2. Less dehydration and oxidation due to tight packaging. When the bone is left in, the paper tears, leaving open spaces and air pockets.
3. The meat can be sliced and served much more readily.
4. The meat can be cut into pieces and packaged to suit the size of the family.
5. The bones can be used for soup stock.

The disadvantages of boning are:

1. The boning takes time. This increases the cost.

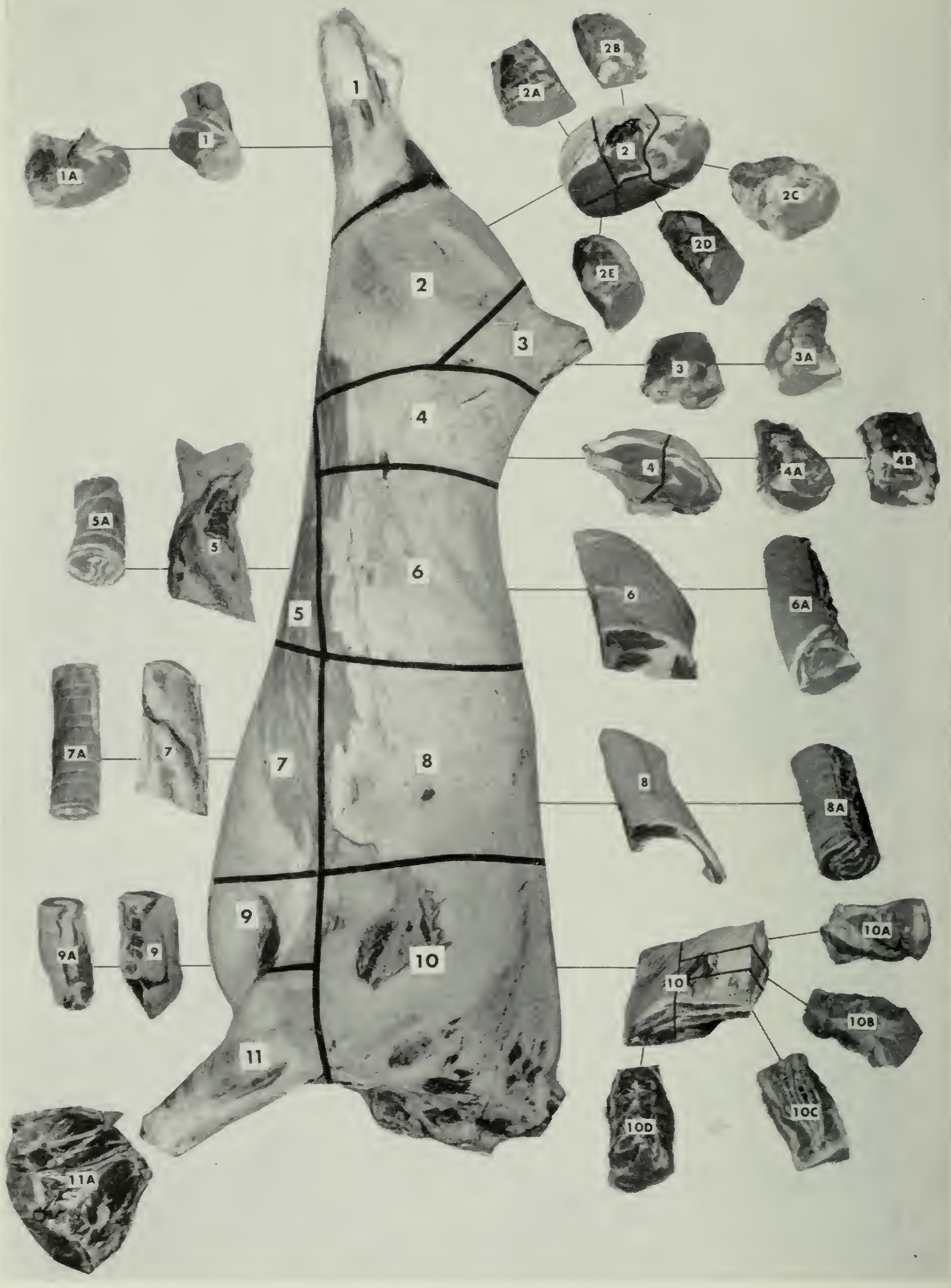
WRAPPING

An important thing to remember when wrapping meat is to do it in such a way that air pockets are eliminated. Satisfactory MVP wrapping materials include heavy waxed locker paper, MST Cellophane, pliofilm, polyethylene, and aluminum foil. Use either the drug store or butcher's method of wrapping (see illustrations) and tape or tie the package securely. MST Cellophane and aluminum foil coverings should be overwrapped to protect the MVP materials from punctures. Also, Cry-O-Vac and poly bags provide excellent protection for frozen meats (see Packaging in introductory section).

THAWING AND COOKING

It is optional whether meat is thawed before it is put on to cook or not. Convenience is generally the deciding factor. No matter what method is used a meat thermometer is desirable for accuracy.

BEEF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10B
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11
11A

Although freezing meat may have some tenderizing effect, it is well to remember that the less tender cuts must still be cooked as such, that is lower temperatures and longer time. The tender cuts such as steaks can still be cooked in the same way as those methods recommended for unfrozen meats, of similar quality.

LENGTH OF STORAGE

	Zero Temperature	*15° Below Zero*
Pork	Average condition — 4 months	Increase several months
Beef	Average condition — 8 months	Increase several months
Veal	Average condition — 8 months	Increase several months
Lamb	Average condition — 8 months	Increase several months

The following illustrates about what yields are expected when meat producing animals are processed:

BEEF

Beef steer — 800 pounds live weight.

Warm dressed weight	532 pounds	60.4%
Cold dressed weight	509 pounds	57.8%
(18 days in the cooler)	————	———
Shrinkage	23 pounds	2.6%

Liver	10½ pounds	Heart	4 pounds
Tongue	4½ pounds	Hide	70 pounds

It must be remembered that dressing percentage varies with age, weight, fill, condition, quality. A poorly finished beef animal will dress out 50 per cent or even lower, while a well finished prime beef steer will dress out 60 per cent or more.

The usual practice in cutting beef is to first, quarter the sides into front and hind, eleven ribs in the front quarter and two in the hind.

As has been mentioned there are various ways of processing meat for the locker, but the following illustrates a method which will make the cuts into sizes to suit the family needs. In the following tables the numbers given represent the large wholesale cuts while the numbers with a letter added are the finished cuts.

BEEF. HIND QUARTER 125¼ LBS.

No. Wholesale Cut	Weight	Weight Boneless	Weight of Bone	Use of Cut
1. Hind Shank	11 lbs. (1A)	6¼ lbs.	4¾ lbs.	Soup Stew Pot Roast Ground Meat
2. Round	43½ lbs.	40 lbs. 2A. 7 lbs. 2B. 7 lbs. 2C. 9 lbs. 2D. 9 lbs. 2E. 8 lbs. 40 lbs.	3½ lbs.	Steaks Roast
3. Rump	10 lbs. (3A)	7 lbs.	3 lbs.	Roast
4. Loin End	21 lbs.	14 lbs. 4A. 7 lbs. 4B. 7 lbs. 14 lbs.	3 lbs.	Steaks Roast
5. Flank	15½ lbs. (5A)	8 lbs.	½ lb.	Flank Steak Stew Ground Meat
6. Short Loin	18¼ lbs. (6A)	13¾ lbs.	3 lbs.	Steaks Roast
Kidney and Fat	6 lbs.			

Boneless Meat	89 lbs.
Bones	17¾ lbs.
Fat and Kidney	15¼ lbs.
Trimmings	3¼ lbs.
	125¼ lbs.

BEEF. FRONT QUARTER 129 LBS.

No. Wholesale Cut	Weight	Weight Boneless	Weight of Bone	Use of Cut
7. Plate	21 lbs. (7A)	16½ lbs.	3 lbs.	Pot Roast Stew Ground Meat
8. Prime Rib	19¾ lbs. (8A)	14 lbs.	5 lbs.	Roast Steaks
9. Brisket	11¼ lbs. (9A)	8 lbs.	2¼ lbs.	Pot Roast Stew
10. Chuck (4 Ribs)	66½ lbs.	48½ lbs. 10A. 9 lbs. 10B. 10 lbs. 10C. 9½ lbs. 10D. 20 lbs. 48½ lbs.	12½ lbs.	Roast Pot Roast Stew
11. Fore Shank	10½ lbs. (11A)	6 lbs.	3¾ lbs.	Soup Stew Ground Meat

Boneless Meat	92 lbs.
Bones	26½ lbs.
Fat	2½ lbs.
Trimmings	7 lbs.
	129 lbs.

SIDE OF BEEF 254¼ LBS.

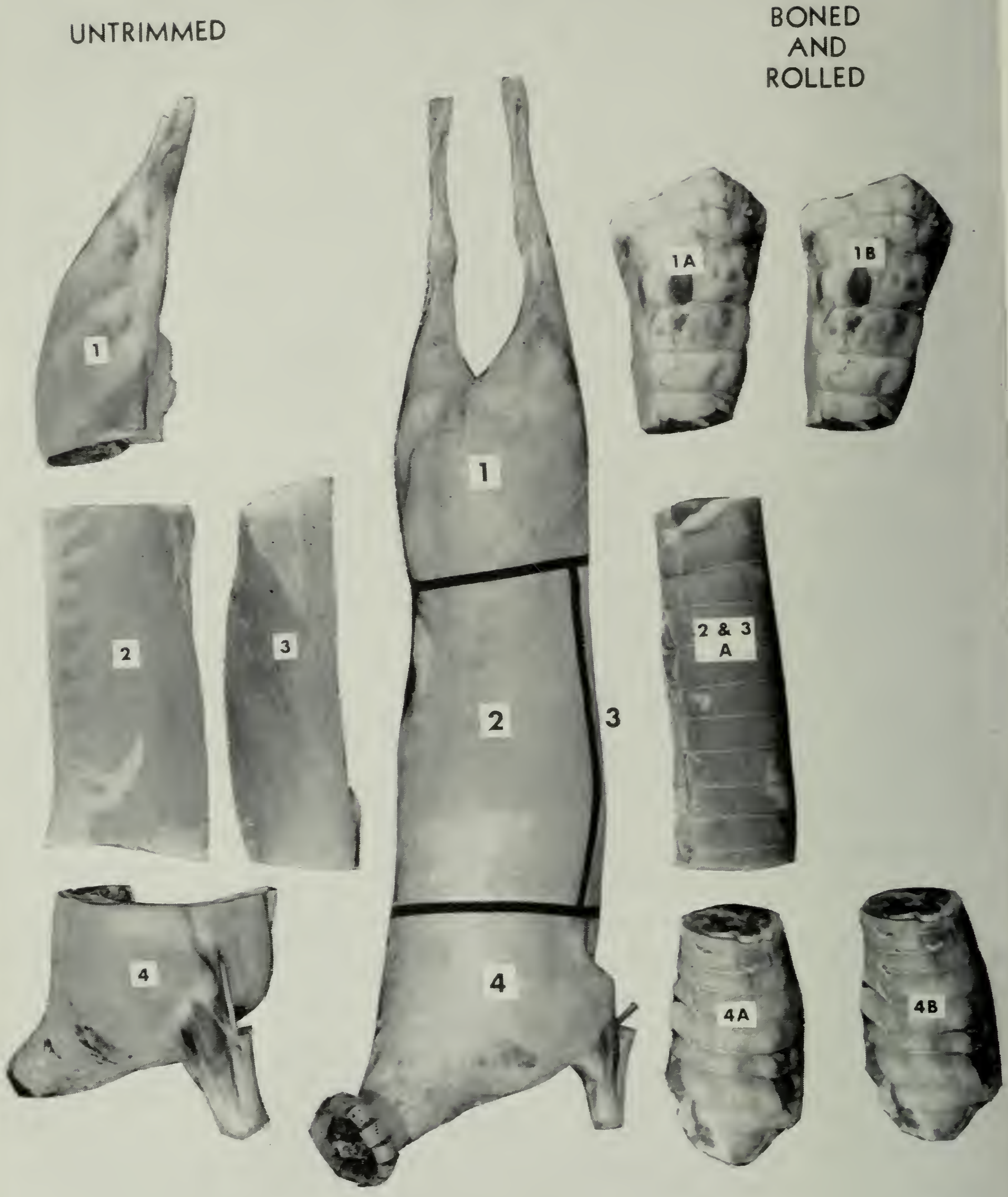
Boneless Meat	182 lbs.	— 71.5%
Bones	44¼ lbs.	— 17.3%
Fat and Kidney	17¾ lbs.	— 6.7%
Trimmings	10¼ lbs.	— 4.0%
	254¼ lbs.	— 99.5%

VEAL

Veal runs very high in moisture. A calf 200 pounds in weight will have about 70 per cent moisture while, in contrast, a 1000 pound steer will be about 52 per cent moisture.

When veal is prepared for the locker similar methods can be used as for beef. The cuts, of course, will be much smaller and due to the moisture content it is much more difficult to get a neat job of boning and rolling.

LAMB



LAMB

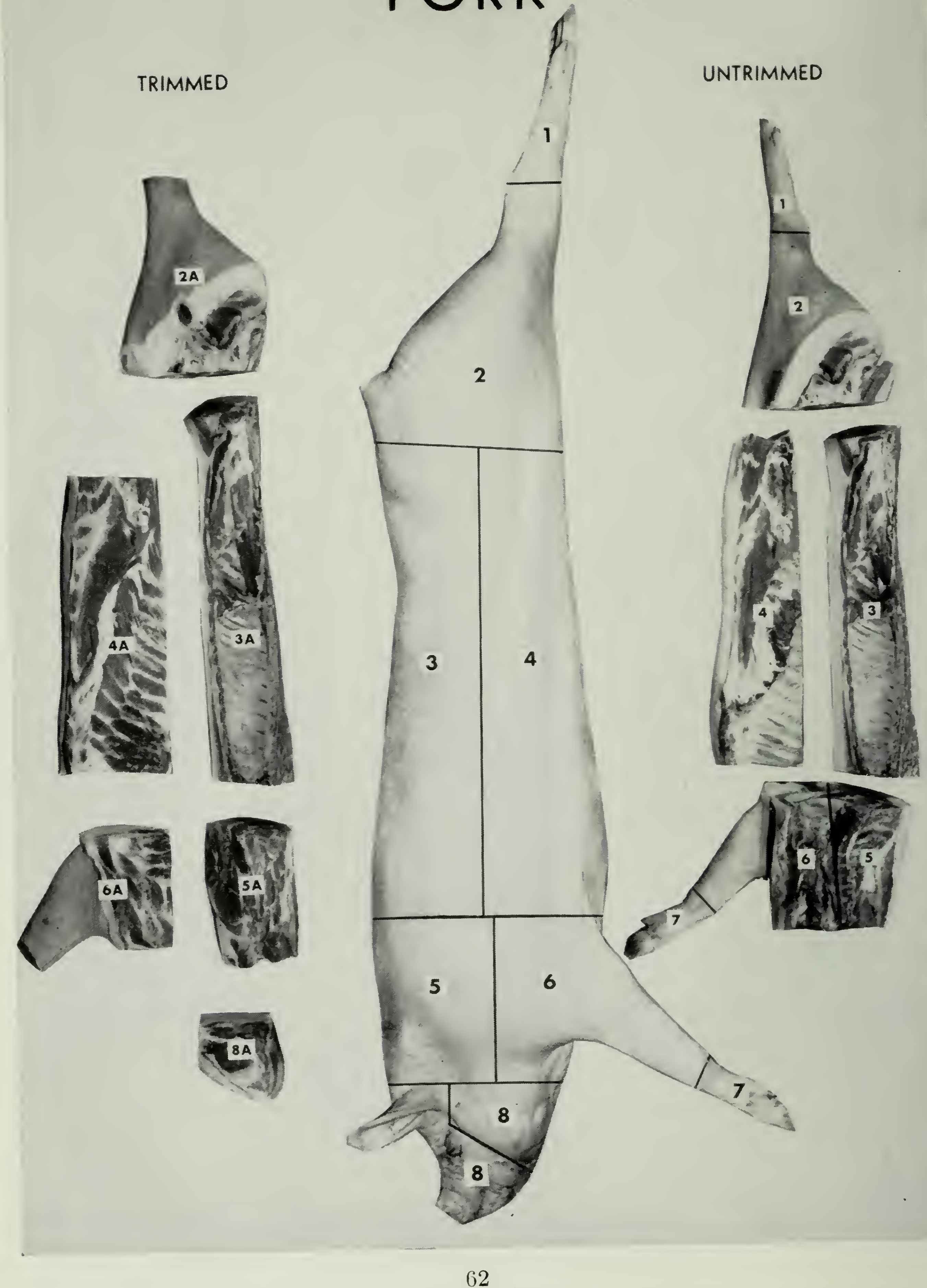
Lambs in good condition should dress out 50 per cent or better depending on fleshing and quality. If a good job is done on the dressing of lamb an attractive carcass results which can be cut up into sizable pieces for the family table. The following is one method of cutting which gets the maximum use of the locker space.

LAMB. 40 LB. CARCASS

No. Wholesale Cut	Weight	Weight Boneless	Weight of Bone	Use of Cut
1. Leg	12 lbs. 8 ozs.	9 lbs. 2 ozs.	3 lbs. 6 ozs.	Roast
		1A. 4 lbs. 8 ozs.		
		1B. 4 lbs. 10 ozs.		
2. Loin	11 lbs. 8 ozs.	9 lbs.	2 lbs. 8 ozs.	Roast
3. Flank				Chops
		2 and 3A. 9 lbs.		Stew
4. Front	13 lbs. 10 ozs.	10 lbs. 10 ozs.	3 lbs.	Roast
				Chops
		4A. 5 lbs.		Stew
		4B. 5 lbs. 10 ozs.		
Kidney and Fat		2 lbs. 6 ozs.		

Boneless Meat	28 lbs. 12 ozs.	— 71.88%
Bones	8 lbs. 14 ozs.	— 22.20%
Fat and Scrap	2 lbs. 6 ozs.	— 5.92%

PORK



PORK

A great many pigs are slaughtered for home use, part of the meat being cured while the rest is used fresh. Fresh pork should not remain in the lockers more than four to six months on the average. As far as cured pork is concerned, the curing process was used in the first place to add to the keeping qualities of the meat and the length of time in the lockers is greatly increased over that of fresh pork. In some cases, however, some locker operators do not encourage the storage of smoked meats due to the odour of the smoke. However, that is a matter for the operator to decide.

Sausages may be stored in the locker but the salt should be left out of the seasoning to safeguard the product.

Bacon type pigs in the regular marketing weights, around 200 pounds, will dress out about 75 per cent.

In the illustrations and the tabulated cuts and weights, it must be remembered that only one-half of the carcass is illustrated, but both sides are represented in the weights.

PORK. 168 LB. CARCASS

No.	Wholesale Cut	Weight	Weight Trimmed	Bones	Use of Cut
1.	Hind Foot				
2.	Ham	38 lbs.	2A. 31 lbs. 2 ozs.	2A.	Steaks Roast
3.	Back	40 lbs. 2 ozs.	*3A. 29 lbs. 12 ozs.		Chops Roast
4.	Belly	29 lbs. 10 ozs.	**4A. 17 lbs. 14 ozs.	5 lbs. Spare Ribs	Bacon
5.					Chops
6.	Shoulder	41 lbs.			Roast
7.			5A. Butts 15 lbs. 14 ozs. 6A. Picnic 17 lbs. 2 ozs.	5 lbs. 4 ozs. Neck Bones	
			1 & 7. Feet 4 lbs. 10 ozs.		
8.	Head	15 lbs. 4 ozs.	8A. Jowl 4 lbs. 4 ozs.	10 lbs.	Bacon Squares
	Leaf Lard	4 lbs.			

Trimmed Meat	116 lbs.
Fat and Trimmings	26 lbs. 2 ozs.
Bones	21 lbs. 4 ozs.
Feet	4 lbs. 10 ozs.
	168 lbs.

MEAT BONED AND ROLLED	
Boneless Meat	90 lbs.
Bones	25 lbs.
Head	10 lbs.
Feet	4 lbs. 10 ozs.
Fat for Lard	26 lbs.
Trimmings	12 lbs. 6 ozs.
	168 lbs.

* 3A. Loin

** 4A. Bacon

Cherry Pie with Ice Cream—A delightful combination to have on hand in your freezer.

Frozen COOKED and PREPARED FOODS

by E. W. FRANKLIN

Freezing cooked and prepared foods is becoming increasingly popular in homes with a freezer. It is a great satisfaction to have a wide variety of ready-to-serve foods on hand for emergency meals. Of course, there are other advantages. Surplus foods may be saved; foods for special occasions can be prepared ahead of time; time and work can be saved by quantity cooking and freezing for later use; and with ready-to-serve foods in the freezer, excellent meals may be prepared quickly and with a minimum of effort.

As a general rule, it is not advisable to tie up valuable freezer space with a large quantity of cooked and prepared food. Nor should it be stored for a long period of time, because the quality of some frozen, cooked foods deteriorates rather quickly.

In order to obtain high quality in these foods, the rules to follow are similar to those for freezing fresh foods: (1) use only high quality ingredients, (2) prepare carefully, (3) package in MVP materials, (4) freeze quickly, (5) store at 0° F. or colder, and (6) do not store too long.

COOKED MEATS

Baked, boiled, and roasted meats of all types may be frozen satisfactorily. Broiled and fried meats are not recommended for freezing. They become soggy, have an uninteresting flavour, and rancidity develops early.

Preferably, cook meat in large pieces, cool, wrap carefully in MVP materials, and freeze. If frozen in small pieces, covering with gravy or sauce helps to retain the flavour.

Various meat combinations may be frozen satisfactorily, such as chili con carne, hash, meat loaves of various types, meat balls in sauce, pork and beans with tomato sauce, pot roast of beef with vegetables, stews, and steaks with sauce. Pack meat combinations in cylindrical or tub-shaped cartons, plastic containers, or glass jars, allowing headspace for expansion during freezing.

Thaw wrapped, cooked meat in its sealed package in the refrigerator or at room temperature. Serve cold or re-heat. Meat combinations are thawed sufficiently to remove from container and then heated in a double-boiler, covered casserole, steamer, or with caution over direct heat.

Meat pies provide an excellent frozen product. They may be baked either before or after freezing. They are packaged for storage similar to fruit pies.

COOKED POULTRY

Poultry may be stuffed and cooked before freezing. Not all stuffing mixtures freeze satisfactorily (see section on Frozen Poultry). Leftover cooked duck, chicken, turkey and dressing may be frozen and stored satisfactorily for a few months. Remove the meat from the bones and pack it as compactly as possible in either cartons, tubs, or poly bags. Package the dressing separately. Alternately, leftover, cooked poultry meat may be diced, packed in tubs or plastic containers, covered with a concentrated broth, and frozen for later use in combination with other foods.

Cooked poultry meat may be used to prepare pies, loaves, and a la king dishes which freeze with excellent results.

COOKIES

All kinds of cookies may be baked, frozen, and stored for 6 months with excellent results. For storing, use any type of MVP package. We prefer poly bags for reasons of convenience and simplicity.

Thaw cookies within the sealed package at room temperature to prevent sogginess.

CAKES

Baked plain cake will store successfully for 10 months, orange and chocolate cake for 5 to 6 months, and sponge and angel cake for 3 to 4 months.

Use a recommended recipe and bake the cake as usual. When cool, place in freezer until frozen. Then remove and wrap in MST Cellophane or aluminum foil. Wrap closely to exclude air and either heat seal or tape joints. Place the cake in a carton for protection against crushing and return it to the freezer.

Thaw frozen cake for 2 hours in its wrapper at room temperature or in a moderate oven (300° F.) for 15 to 20 minutes.

FROSTINGS AND FILLINGS

Frosting and filling may be added to the cake before freezing if desired. Frostings made with confectioner's sugar, i.e. butter-type frostings, fudge, and penuche, will store at least 4 months. White mountain frosting can be stored successfully for 2 to 4 weeks. Date, lemon, and cream fillings store well for 2 to 4 months. Coconut tends to fall off butter-type frostings at low temperatures. Therefore, for freezing chocolate-coconut frosting, use a recipe containing cornstarch, as coconut adheres to this type.

Prepare the frosting and filling as usual and apply to the cake. Place the completed product in the freezer until frozen. Then, remove briefly for wrapping and place in a carton (see Cakes) for storage. Cakes with mountain frosting should be placed in a carton which is then overwrapped with MST Cellophane. This prevents the wrapping from touching the frosting.

Thaw frosted cakes for 2 hours in their wrappers at room temperature. Do not thaw frosted cakes in the oven as the frosting will melt.

FRUIT PIES

Fruit pies may be baked before or after freezing, but we have had better results when the pies are baked after freezing storage. Frozen unbaked fruit pies store satisfactorily for 8 months. Either fresh or frozen fruits may be used. Fresh apple and peach slices must be blanched to preserve their colour during storage. Immerse the slices in boiling water for exactly 1 minute, cool briefly in cold water, drain, and place in pie. If using frozen fruit, allow it to partially thaw and drain before using.

Prepare the pies as for baking but do not cut slits in the top crust. Grease the pie plate well so that the frozen pie will slip out easily for wrapping, or prepare the pie in an ungreased cardboard plate in which it can be frozen, wrapped, and stored. Also, aluminum foil pie plates are useful as the pies can be baked in them later. Place the raw pie in the freezer until frozen. Remove and wrap quickly in MST Cellophane or aluminum foil. Either heat-seal the Cellophane or use locker tape. Return the wrapped pie to the freezer immediately.

To bake, remove the wrapper and cut slits in the top crust. Place in a 450° F. oven for 30 to 35 minutes. Reduce the heat to 350° F. and complete baking. Alternately, the frozen pie may be baked continuously at 400° F. for 45 to 50 minutes.

FILLED PIES

Chocolate, cream, butterscotch, lemon, chocolate chiffon, custard, and lemon sponge pies may be frozen and stored with fairly satisfactory results for 2 months. There is a tendency for custard and cream type pies to separate and "weep" when frozen and thawed.

Prepare the pie as usual, but to each filling to stabilize it, add 1 tablespoon of gelatin, which has been soaked in ¼ cup cold water. Cool the pie and freeze it. Then remove briefly from the freezer for wrapping. Wrap chocolate, cream, butterscotch, and lemon pies in aluminum foil, pressing the foil against the surface of the filling. Or, place a circle of aluminum foil tightly against the surface of the filling and the edge crust, and then overwrap it with MST Cellophane, which is heat-sealed or taped. Wrap chiffon, custard, and sponge pies as usual in MST Cellophane only.

Thaw chiffon and sponge pies in their wrappers at room temperature. Unwrap frozen chocolate, cream, custard, butterscotch, and lemon pies and thaw in a moderate (300° F.) oven for 10 to 15 minutes. Do not allow to heat.

Chocolate, butterscotch, and lemon pie fillings may be prepared and frozen in bulk in packages for later use in pies. When required, thaw in a double boiler, stirring occasionally, and pour into a cooked pie shell. Also, cooked pie shells may be frozen and stored satisfactorily for 6 months.

QUICKBREADS

Quickbreads include baking powder biscuits, muffins, fruit and nut loaves, doughnuts, and gingerbread. They will store frozen for 2 to 3 months.

Prepare according to a standard recipe. When cool, place in cartons and overwrap with heat-sealed MST Cellophane. Or, store in heat-sealed MST Cellophane bags. Poly bags are satisfactory for storage but cannot be used for quick oven thawing as they melt.

Thaw in their wrappers at room temperature or in a moderate (300° F.) oven. Serve warm or cold, as preferred.

YEAST BREADS AND ROLLS

Yeast breads should be frozen completely baked. Rolls may be frozen either completely or partially baked. Partially baking the rolls will give "Brown and Serve" rolls for later use. Loaves and rolls will store 3 months. Wrapped, sliced bread from the grocery store may be frozen "as is" and stored satisfactorily for 1 to 2 weeks.

Prepare the loaves and rolls according to a standard recipe. Bake the loaves and either completely or partially bake the rolls. For "Brown and Serve" rolls, at second rising, allow the rolls to rise only three-quarters as high as regular rolls. Bake at 250° F. for 40 minutes. Let stand 20 minutes in the pan to set. Remove and cool. When cool, seal the loaves in MST Cellophane or aluminum foil, and freeze.

Thaw baked rolls and loaves in their wrappers at room temperature, or in a moderate (300° F.) oven. Thaw and bake "Brown and Serve" rolls at 425° F. for 8 to 10 minutes. Frozen, sliced, store bread may be used immediately by toasting it.

SALADS

Vegetable salads are not usually frozen because they lose their desirable crispness when thawed. Also, freezing may cause undesirable changes in some common ingredients of salads. For example, the whites of hard-cooked eggs become rubbery and tough, nuts bitter and discoloured, mayonnaise and cooked dressings curdled, raw apples pithy and discoloured, grapes flabby, and potatoes mushy and dark in appearance.

For freezing, use fruit salads which have as a base combinations of cream cheese, cottage cheese, or whipped cream with mayonnaise. Gelatin improves mayonnaise and whipped cream mixtures.

Package ready-to-serve salads in cylindrical or tub-type cartons for freezing. Discs of cellophane or aluminum foil may be placed in the cartons to separate individual servings. Or, freeze individual servings in ice-cube trays or paper cups. When frozen, remove cubes from tray and package cubes or paper cups in poly bags for storing in the freezer.

Thaw fruit salads only slightly in the refrigerator before serving. Fresh fruits may be diced, mixed in desired proportions and combinations, and frozen for use later in salads. To prepare for serving, merely thaw and mix with a salad dressing. Also, cooked chicken and turkey meat may be diced and frozen for use later as a salad ingredient.

SANDWICHES

Not all fillings commonly used for sandwiches are satisfactory after freezing. Hard-cooked egg white becomes rubbery and tough, mayonnaise tends to curdle, and crisp vegetables lose their crispness.

The following sandwich fillings have been found satisfactory for freezing storage: up to 6 months — cream cheese with nuts or olives, processed cheese, peanut butter, salmon, sardine, and sliced turkey; up to 3 months — egg yolk, minced ham and pickle, sliced ham and mustard, sliced lamb, tongue, and tuna fish; up to 1 month — bologna; and up to 2 weeks — jam and jelly. Jam and jelly fillings tend to soak through the bread rather quickly.

To prepare sandwiches for freezing use, preferably, day old bread which usually results in a more uniformly moist sandwich when thawed. Work quickly to avoid drying. Spread the bread liberally with butter and filling.

Package the sandwiches, with crusts left on, in groups of 6 to 8. Place an extra slice of bread or a crust at each end of the group for protection against drying. For longer than 2 weeks of storage seal each group in MST Cellophane, aluminum foil, or poly bags. For storage up to 2 weeks a carefully applied double wrap of ordinary wax paper is usually satisfactory. Alternately, sandwiches may be wrapped individually in wax paper and packed in a metal container with a tight-fitting lid for freezing storage.

Defrost sandwiches in their sealed wraps at room temperature before serving.

SOUPS

Almost all soups prepared from standard recipes may be frozen satisfactorily. Soups especially recommended for freezing include: chicken noodle, chowder, onion, cream of corn, split pea, black bean, mixed vegetable, concentrated meat stock, and purees of asparagus, carrot, celery and peas. Freezing concentrated bases for soups is a preferred method because of less bulk. The milk or water is added at time of thawing. Seasonings lose strength during freezing storage and are usually added when the soup is reheated for serving.

Soups should be packaged in water-tight, MVP containers allowing room for expansion during freezing. Or, freeze the soup in ice-cube trays and package the frozen cubes of soup in poly bags. Soups may be thawed directly over heat. If liquid is to be added, place it in the container with the frozen soup.

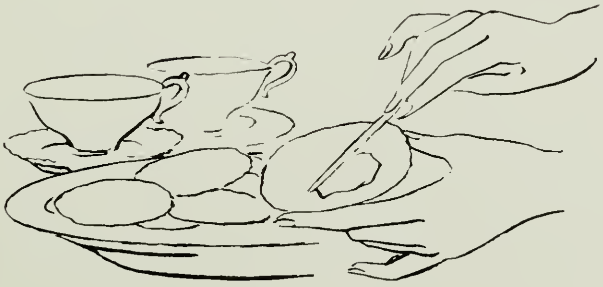
MISCELLANEOUS FOODS

Cheese

All kinds of cheese can be frozen and stored for 5 to 6 months, if desired. Some tend to be more crumbly after freezing. Use relatively small pieces and seal them very carefully in aluminum foil. Place against the freezer wall to obtain rapid freezing. Cottage cheese packed in cartons will freeze and store satisfactorily for about 1 month at 0° F. Completely thaw frozen cheese and bring it to room temperature for serving in order to obtain full flavour.

Butter

Butter may be frozen and stored satisfactorily for 8 months or more. The parchment paper in which it is packaged is usually sufficient protection, although for long storage it should be overwrapped with MVP materials or packed in sealed cartons.



NOTES

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COMMON WEEDS OF ONTARIO

ONTARIO DEPARTMENT of AGRICULTURE

PARLIAMENT BUILDINGS - TORONTO, CANADA

Common Weeds of Ontario

F. H. MONTGOMERY, *Professor of Botany*
Ontario Agricultural College

INTRODUCTION

In most agricultural areas of Ontario, losses from weeds exceed, by far, those from the multitude of other pests with which the farmer has to contend. Certain losses from weeds, as those associated with the cost of control measures, or say with livestock poisoning, are readily appreciated by farmers. Others, like the losses from reduced yields and quality of field crop and livestock products are more insidious, in that they exact a tremendous annual toll of which the farmer is usually unaware. For example, in Ontario, conservative estimates would place the loss from reduction in crop yields alone at from 30 million to 40 million dollars per year.

Accurate identification of weeds is very helpful for efficient and effective weed control. In this bulletin about 125 of the more common weeds found in Ontario are described and illustrated, and it is hoped that this will greatly assist farmers and others, who are not trained in plant identification, to recognize these pests. Some weeds are found in practically all the agricultural areas of the Province; others may have a more restricted distribution. However, wherever they may appear, they may be considered to be a nuisance.

Certain losses from weeds may be attributed to the fact that these plants act as hosts for insect and plant disease pests of economic plants. These have been noted either in tabular form or in the text.

A new feature of this bulletin is the photographic illustration of fruits or seeds of some 114 weeds in the form in which they are most likely to be seen. These reproductions should assist farmers and seedsmen in the identification of weed seeds.

WEED CONTROL

The following are considered to be basic requirements for a successful weed control program:

1. Use weed free seed of approved varieties or strains.
2. Sow seed at the correct depth in moist, weed free, firm seed-bed.
3. Maintain the soil at a satisfactory pH (acidity) and fertility level by applying lime and fertilizer if necessary.
4. Clean all equipment, especially that used for tillage and harvesting, before bringing it on the farm, or before moving to other fields on the farm.
5. Spray, mow, or otherwise control weeds before they ripen seeds on fence-rows, roadsides, barnyards, and abandoned land. Seeds from these weeds may be carried to fields by birds, animals, wind, or water run-off.
6. Mow, utilize for grass silage, or otherwise destroy weedy crops. Such crops are unproductive, and serve as a source of weed seeds for cleaner areas of the farm.

7. Clean small seeds out of feed grain, and grind feed containing larger weed seeds. Intact weed seeds readily pass through the digestive tracts of livestock.
8. Ensure a thorough kill of weeds by timely tillage operations with proper equipment in correct adjustment. Usually tillage in hot, dry weather is most effective in killing weeds.
9. Follow an approved crop rotation. By rotating crops no one group of weeds can become established.

Weed control measures are closely related to the life habits of weeds. These life habits may be classified as follows:

Annuals — Weeds that usually germinate, bloom, produce seeds, and die in one growing season. Examples: Common ragweed, wild mustard.

Winter Annuals — Weeds that may either 1. germinate and produce a leafy rosette in the fall, and then flower, seed, and die the following summer, or 2. germinate in the spring, and act as a normal annual. Examples: Stinkweed, shepherd's purse.

Biennials — Weeds that usually germinate and produce a leafy rosette one season, and then complete their life cycle and die the next. Examples: Wild carrot, burdock.

Perennials (Herbaceous) — Weeds that live a number of years, developing each year from underground stems, or roots, or crowns. Examples: Perennial sow thistle, dandelion.

Control measures for annual, winter annual, and biennial weeds are largely designed to destroy the weed plants before they offer too much competition to the crop, or, before they go to seed. Tillage, spraying or mowing are the main methods that are used. Control is often difficult, because seeds of many weeds may lie buried for years in the soil without germinating, and because the germination of many weed seeds coincides with the germination and early seedling growth of the crops in which they are troublesome.

For perennial weeds it is necessary to prevent their spread by seeds, as for annuals, and, in addition, to eradicate a fleshy root system that has many undeveloped buds and adequate food reserves. Since (except for quack-grass) most of these roots are below normal tillage levels, attempts at dragging them out are unsuccessful and usually result in root pieces being dragged to uninfested parts of the field. On the other hand, the roots may be killed by starvation if no green growth is allowed to become established on the ground surface. The type of operation necessary to do this has been termed *"black fallow."*

Black fallow operations for many perennial weeds are most successful during late summer and fall. At this time these weeds are replenishing the food reserves that will be used to make new growth the following spring. With certain persistent weeds, such as leafy spurge, at least two seasons black fallow from spring to fall are necessary for eradication. Chemical treatments are also very valuable in handling perennial weeds.

Chemical Weed Control

Control of weeds by the use of chemicals has made rapid strides in recent years. To-day there are a number of different types of treatments, involving a wide range of chemicals, that may be worked into a farm program. Since recommendations must be followed closely the reader is referred to the current "Guides to Chemical Weed Control," and the "Handbook on Chemical Weed Control," available from the Agricultural Representative's office.

The Weed Control Act for Ontario

Certain regulations regarding weeds and their control have been formulated by the provincial government and brought together to make up what is called "The Weed Control Act." The act outlines clearly the duties of land occupants or owners, municipalities, townships, counties, and districts with respect to noxious weeds. "Every occupant of land, or if the land is unoccupied, the owner, shall destroy all noxious weeds thereon as often in the year as is necessary to prevent the ripening of weed seeds. Every road authority within the meaning of the Highway Improvement Act is considered to be an occupant of land." It is responsible for weed control on the land under its jurisdiction.

Seed grain has been recognized as an important mode of distribution of weed seeds. In order to reduce weed seed dispersal with seed grain, the act states that seed cleaning plants must be licensed and the plants must operate up to the minimum standards prescribed in the regulations.

Threshing machines, combines, and silo filling equipment have also been agents for weed seed transportation from farm to farm. Such machines, which are moved from one locality to another, must be thoroughly cleaned of debris and seeds after using, or before moving to another location.

A few years ago, when one wished to make a good weed collection, he found a collector's paradise around grain elevators, grist mills, flour mills, and grain grinding plants. It is now required that all such plants dispose of refuse containing weed seeds in such a manner as will prevent weed seeds from growing or spreading.

To enforce its provisions, the act requires that "The council of every county, every municipality not forming part of a county for municipal purposes, and every municipality in a territorial district shall, and any town, village or township in a county may, pass by-laws appointing one or more persons as inspectors." These inspectors have the authority to inspect farm buildings, other than dwelling houses, and farm machinery or vehicles at any time between sunrise and sunset. They may ask land occupants to destroy weeds and will give advice in the destroying of noxious weeds. They also have the authority to have the weeds destroyed at the expense of the occupant or owner if he fails to give the required co-operation. All local governing bodies are subject to the same inspection, and the clauses of the act relating to the destruction of weeds as the individual.

Throughout the province the weed inspectors receive much assistance from many organizations interested in weed control, and the majority of individuals are willing to co-operate in the destruction of plant pests. However, it is impossible, in an area as great as the province of Ontario, to investigate every possible habitat for noxious weeds. This necessarily places the main responsibility for weed control on the farmers, those commercially handling grains, the municipalities and the road authorities. If these are interested in increasing both the financial and aesthetic value of their property they will carry on their own thorough weed control program without the legal enforcement of the act.

In addition to the Weed Control Act for Ontario, there is the Seeds Act administered by the Canada Department of Agriculture. This deals with the sale of seed to be used for seeding purposes.

WEEDS THAT ARE HOSTS OF INSECTS INJURIOUS TO CULTIVATED PLANTS

Weed Host	Insect Pest	Cultivated Plants Attacked
Docks, burdock, giant ragweed.	Stalk-borer	Dahlias, hollyhocks, asters, rhubarb, pepper, tomatoes, potatoes, tobacco, corn.
Docks	Rhubarb-curculio	Rhubarb.
Docks, peppergrass, shepherd's purse, pigweeds.	Melon-aphid	Melons, cucumber.
Lamb's quarters, shepherd's purse, common ragweed.	Potato-aphid	Potatoes.
Lamb's quarters, pigweeds, chickweeds.	Spinach flea-beetle	Spinach.
Lamb's quarters, pigweeds, chickweeds.	Spinach leaf-miner	Spinach, chard, beets, mangolds.
Pigweeds, wild carrot, mullein, goldenrods, asters.	Tarnished plant-bug	Dahlias, chrysanthemums, celery, beets, strawberries, asters.
Mustards.	Cabbage-worm	Cabbage, cauliflower, turnips, rape, brussels sprouts, broccoli, kale.
Mustards.	Cabbage-aphid	Cabbage, cauliflower, turnips, rape, brussels sprouts, broccoli, kale.
Mustards.	Striped flea-beetles	Turnips, radishes, cabbage, cauliflower.
Mustards.	Turnip-aphid	Turnips.
Cinquefoils.	Strawberry-weevil	Strawberries.
Black medick, vetches.	Pea-aphid	Peas, alfalfa.
Wild parsnip.	Carrot rust-fly	Carrots, parsnips, celery, parsley.
Ribgrass.	Rosy apple-aphid	Certain apple varieties.

HORSETAIL FAMILY (*EQUISETACEAE*)

Field Horsetail, Scouring-rush, *Equisetum arvense* L. (Fig. 1). The horsetail is usually abundant in soil that has poor drainage, and is particularly common in low, sandy land. It has creeping, branching, underground stems which produce two aboveground structures. In the early spring a brownish, spore-producing stem appears (Fig. 1A). This dies off after shedding the spores, and is succeeded by a green, bushy, vegetative structure (Fig. 1B). The stems of this structure are impregnated with silica, making the plant rough.

Other species of horsetail occur in low meadows and pastures, but their characteristics, in general, are similar to the field horsetail.

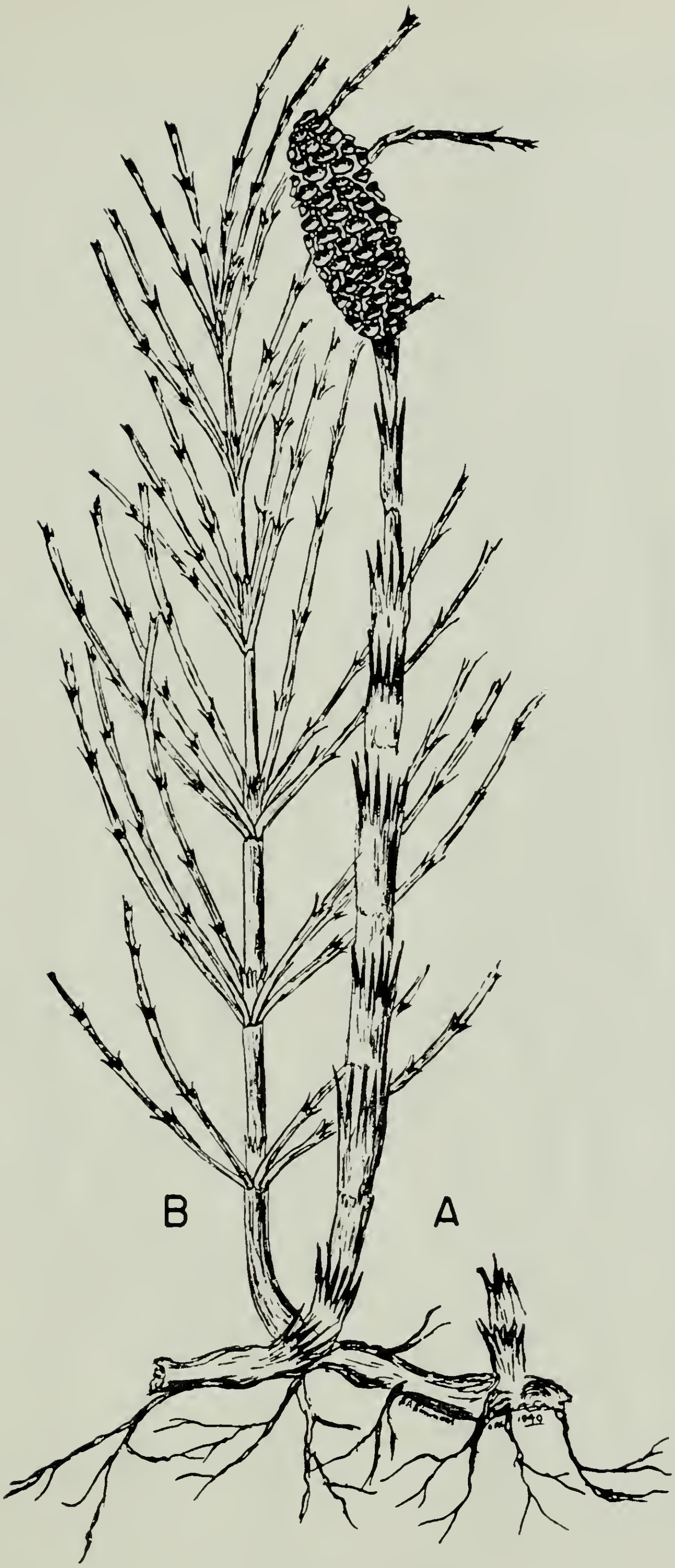

Fig. 1. Field horsetail.

A, Spore producing branch. B, Vegetative branch.

Horsetails contain substances that are poisonous to livestock if eaten in quantities in pasture or in hay. Animals should not be pastured where the weed is abundant, and hay containing it should not be used.

This plant, and related species, often harbour the fungus *Rhizoctonia,* which is a serious parasite on potatoes, tomatoes and other cultivated crops.

COUCH, QUACK OR SCUTCH GRASS

AGROPYRON REPENS

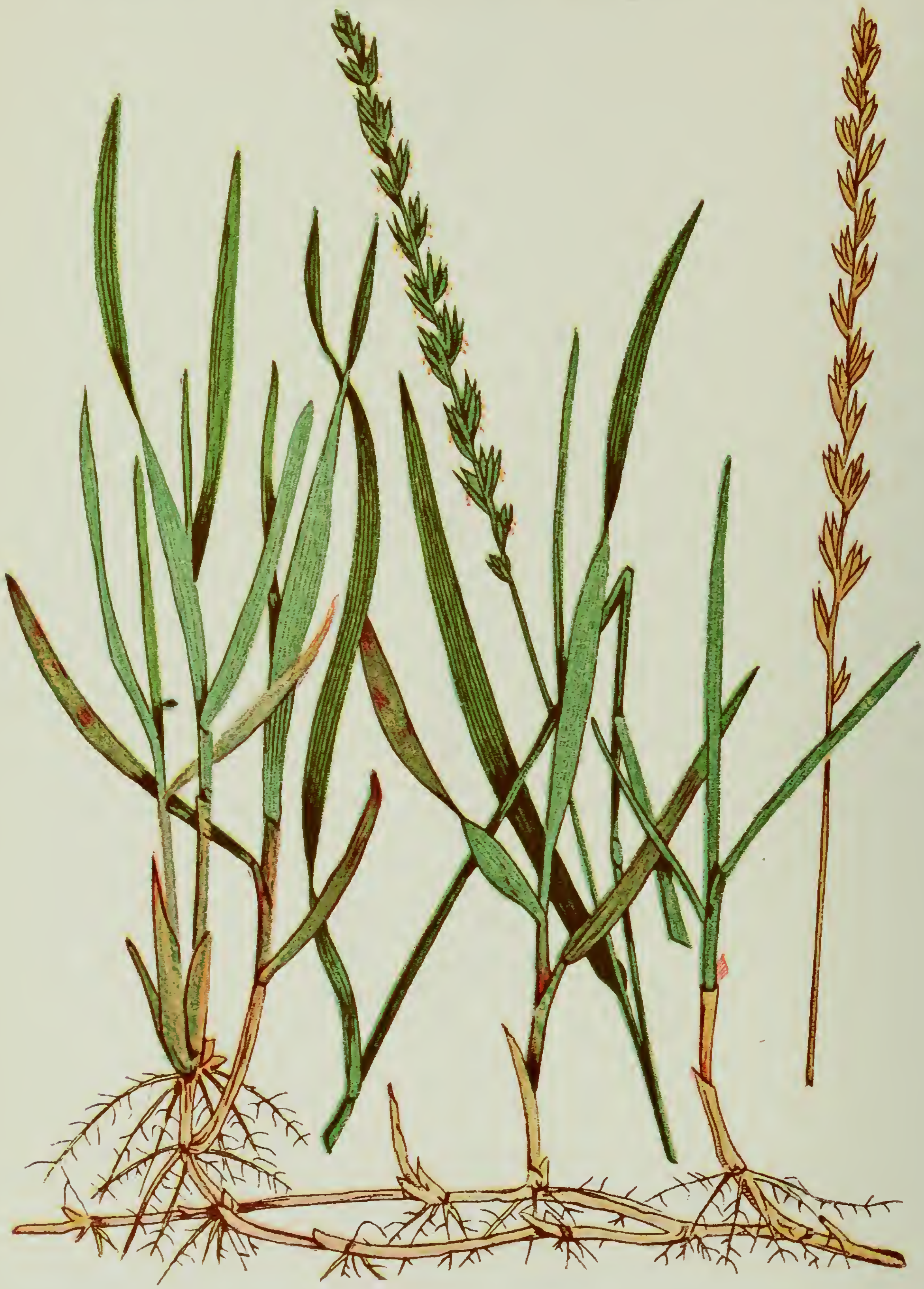

Plate 1. Couch-grass.

GRASS FAMILY (*GRAMINEAE*)

Couch-Grass, Twitch-grass, Quack-grass, *Agropyron repens* (L.) Beauv. (Plate 1). This grass is a perennial, and very persistent once it has become introduced. The creeping, whitish or yellowish underground stems (rhizomes) may produce roots and upright stems at each joint; therefore, any part of this rhizome left in the ground during cultivation is a potential source of new growth. The stems are mostly smooth, and the leaves may be slightly hairy on the upper surface. The flowers are in groups (spikelets) on opposite sides of a zig-zag continuation of the stem. The seed is enclosed by two grayish bracts (Plate 17, no. 4).

Couch-grass is a host for ergot, a very poisonous fungus. Ergots can be recognized as the black masses that have developed in place of the seed. Pastures and hay containing any quantities of mature couch-grass should be watched for this fungus.

Wild Barley, Squirrel-tail grass, *Hordeum jubatum* L. (Fig. 2). A biennial or perennial grass, producing several stems one to two feet high. The stems are slightly bent at the base and smooth, but the leaves are rough-hairy. The spikes (heads) are nodding, and resemble barley in their general appearance, though more bushy. When young, the spikes are green, but turn a shiny, golden colour when mature, and are quite conspicuous.

The barbed awns may stick in the hair of animals, and may get into their nostrils, mouth and eyes, causing much trouble.

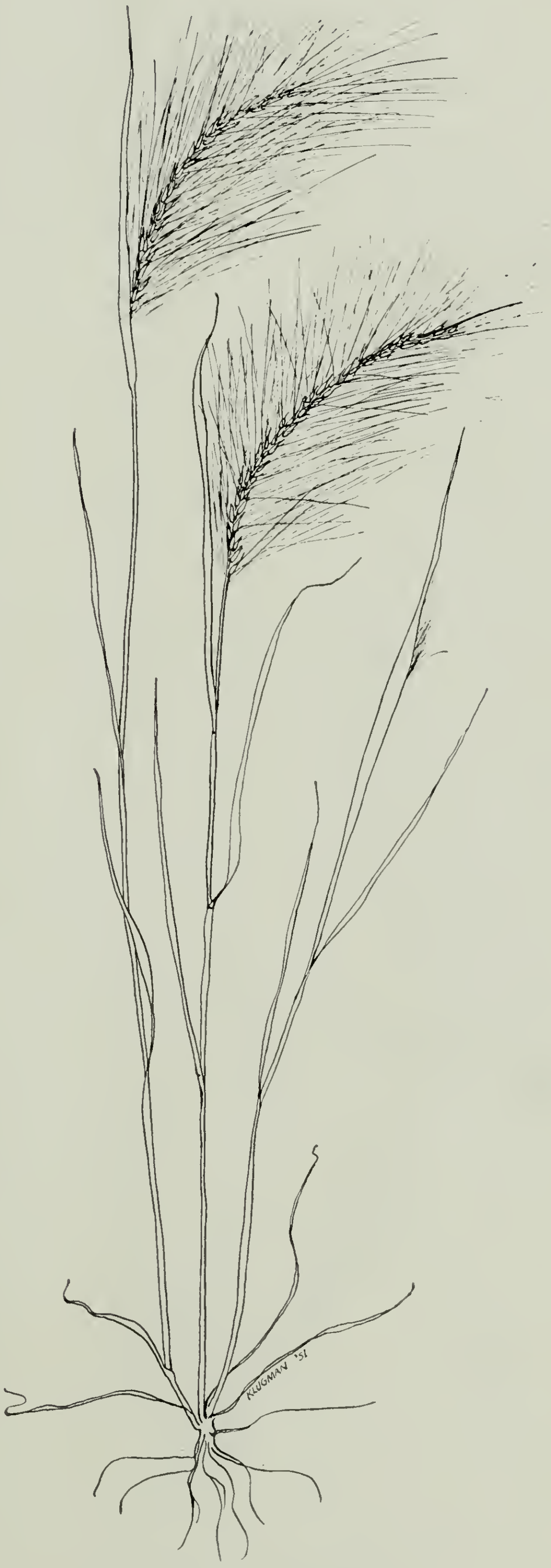

FIG. 2. Wild barley.

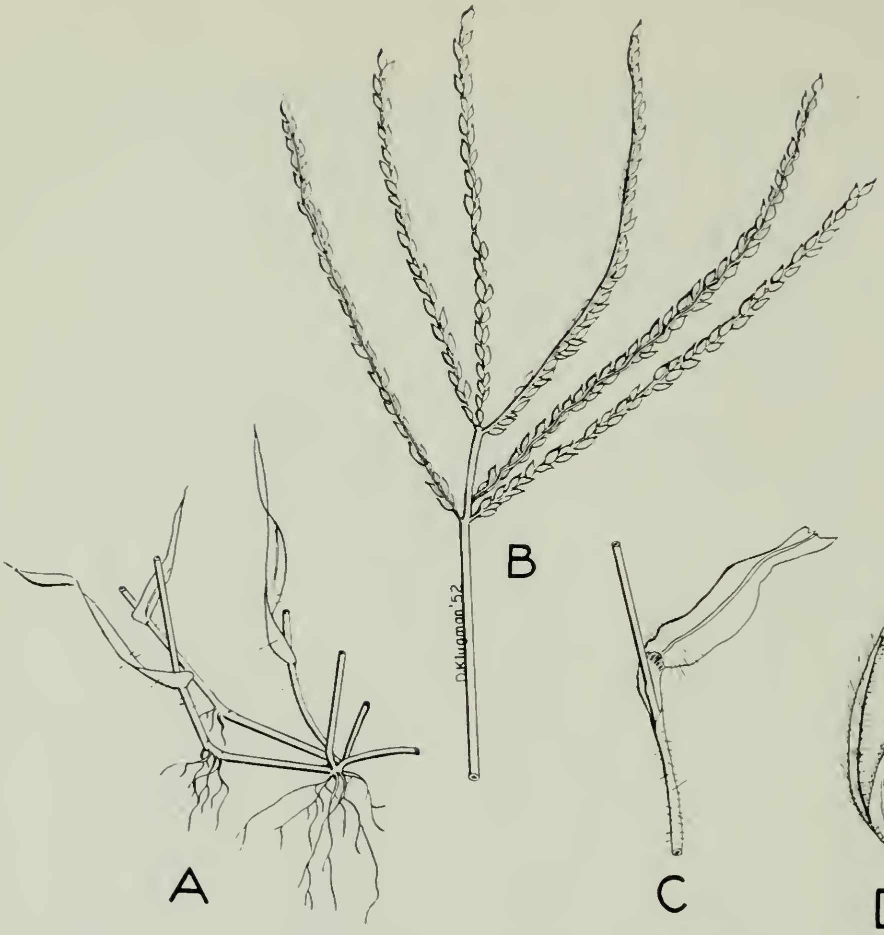

Fig. 3. Hairy crabgrass. A, Basal portion of stem. B, Flower branches. C, Part of stem and leaf. D, Fruit of hairy crabgrass. E, Fruit of smooth crabgrass.

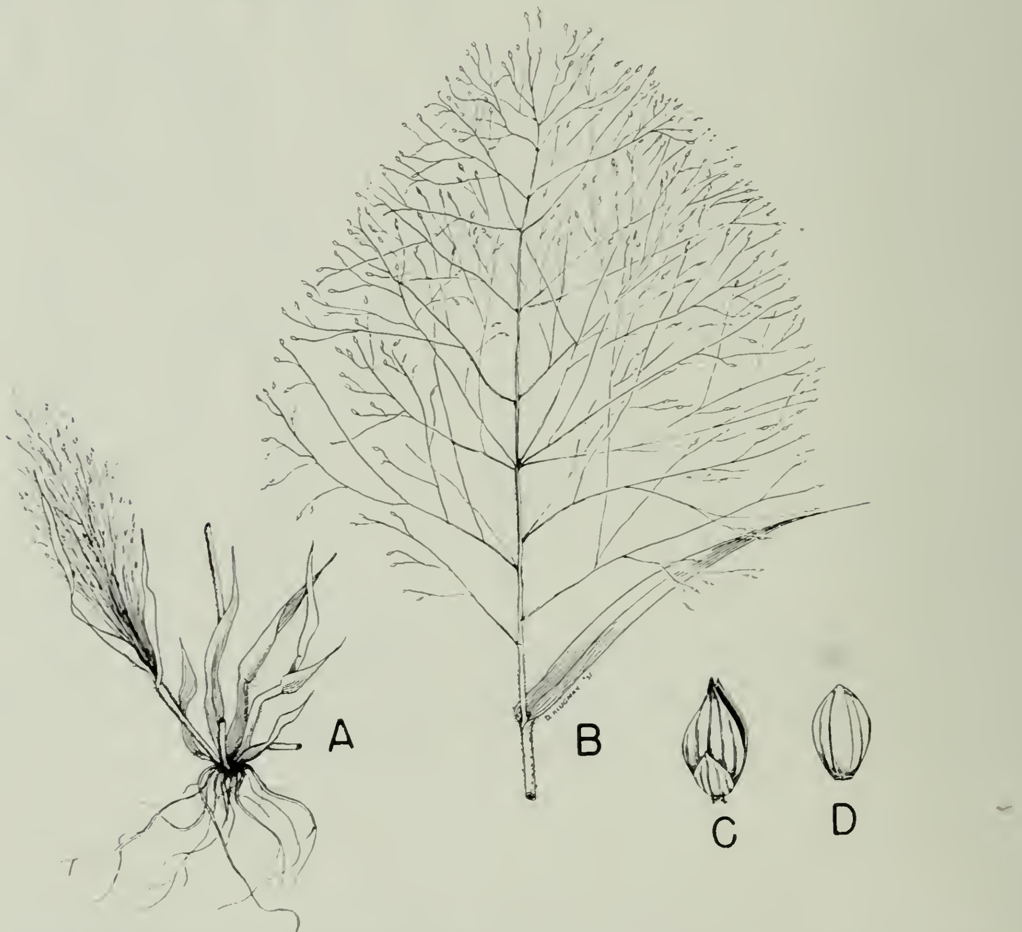

Fig. 4. Old witch-grass. A, Lower portion of stem. B, Panicle. C and D, Fruit.

Wild Oats, *Avena fatua* L., which is a common weed in grain fields in western Canada, does not appear to be a serious weed in Ontario. Seeds may be found in feed grain, and care should be taken in the disposal of any waste feed or screenings. However, the possibility of its importation and establishment should not be overlooked, and any infestations should be eradicated. Seed (Plate 17, no. 5).

Hairy Crabgrass, Finger-grass, *Digitaria sanguinalis* (L.) Scop. (Fig. 3). This is an annual grass that ripens its seed in the fall. The branching, smooth stems may be erect or prostrate, and roots form at the joints which contact the ground (Fig. 3A). The leaves are short and broad, and both the leaves and leaf-sheaths are hairy (Fig. 3C). When they mature they become purplish coloured. The flowering structure consists of from 8 to 12 "fingers" in one or two whorls at the top of the stems. The flowering branches are flat, and the grains are arranged alternately on one side of them (Fig. 3B). The seed coverings have numerous short hairs (Fig. 3D, Plate 17, no. 10).

Smooth Crabgrass, Smooth finger-grass, *Digitaria ischaemum* (Schreb.) Muhl., can be distinguished from the above species by the smooth, hairless leaves and leaf-sheaths. There are also fewer "fingers," and the seeds are smaller than those of the hairy crabgrass (Fig. 3E).

Old Witch-grass, Tumble-grass, *Panicum capillare* L. (Fig. 4), is an annual grass occurring very frequently in ground that has been cultivated. It branches near the ground, and the stems and leaves are very hairy. The leaves are broad at the base, and taper to a point. The much-branched flowering portion produces many single, small, shiny, greenish grains. The seed-bearing parts of the stem often break off, and are blown around by the wind, thus scattering the seed (Fig. 4C and D, Plate 17, no. 11).

Barnyard-Grass, *Echinochloa crus-galli* (L.) Beauv. (Fig. 5). This grass is found in a variety of habitats in the fall of the year. It may grow from 1 to 5 feet high, and often branches near the surface of the ground. The stems are smooth and rather stout, and the leaves are smooth and broad. The flowering portion of the stem consists of a number of branches bearing 2 to 4 rows of purplish grains on one side of the branches. The outer coverings around the seed have numerous little spines and a short or long barbed awn (Fig. 5B and Plate 17, no. 3). The inner coverings are smooth (Fig. 5C).

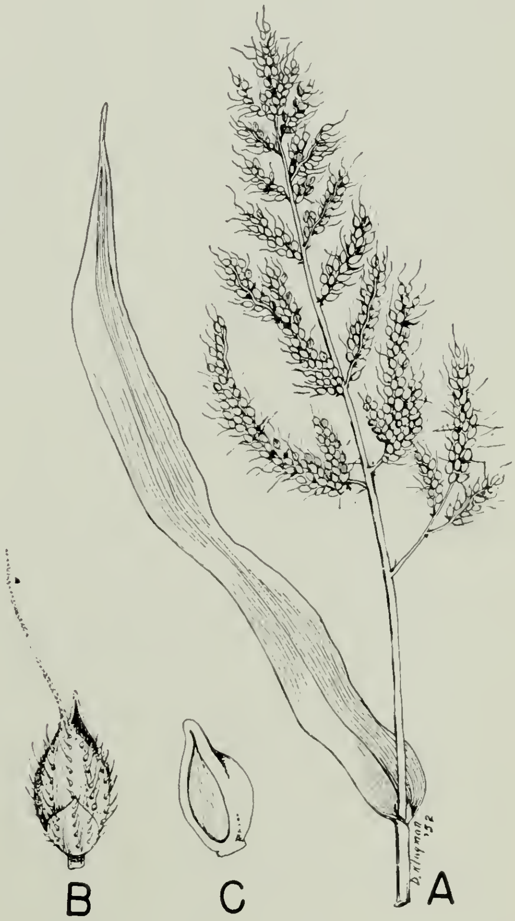

Fig. 5. Barnyard-grass.
A, Upper portion of stem. B, Fruit.
C, Seed with inner coverings.

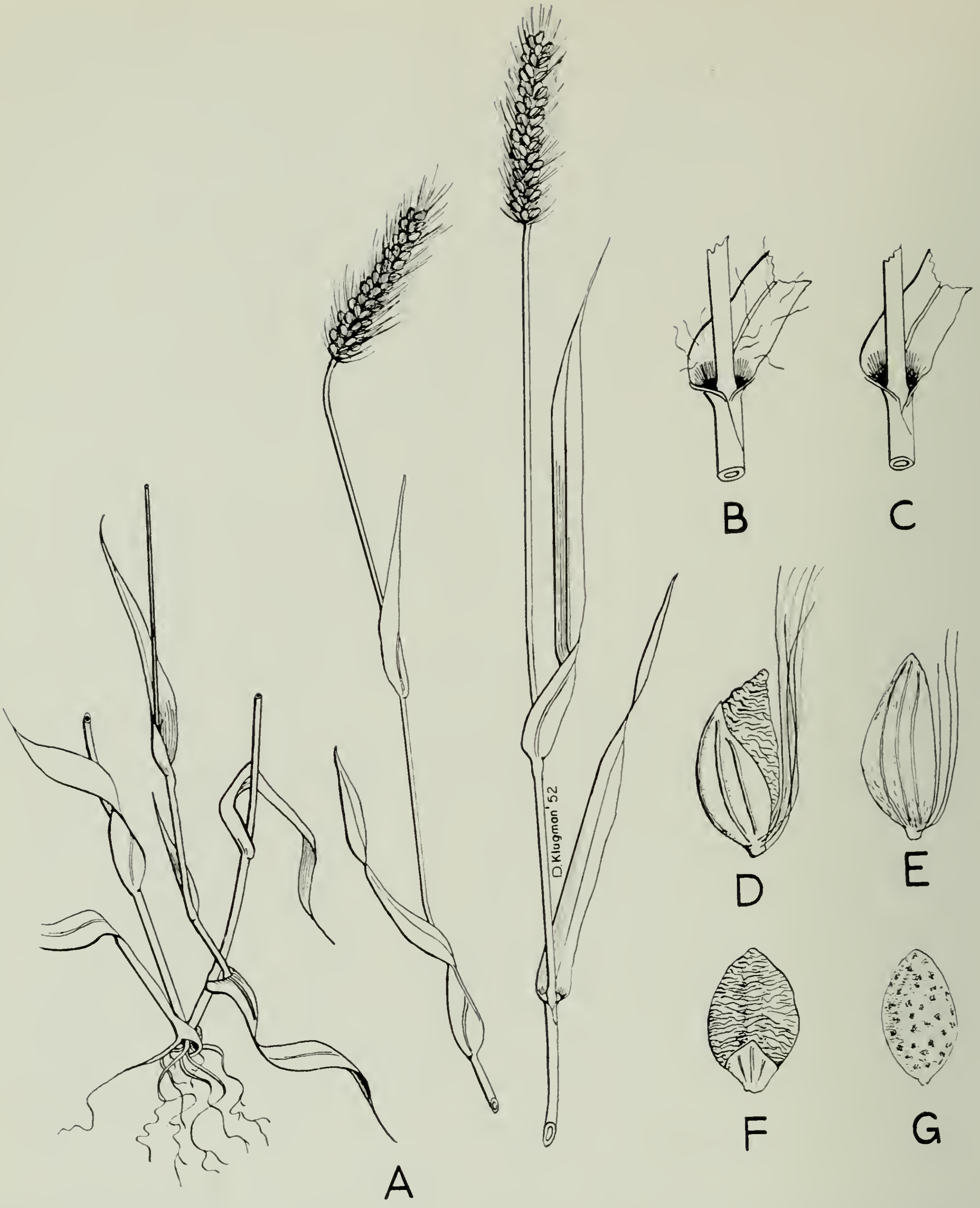

FIG. 6. Fox-tail grass. A, General habit. C, E, and G, Leaf, fruit and seed of green fox-tail. B, D, and F, Leaf, fruit and seed of yellow fox-tail.

Green Fox-Tail Grass, *Setaria viridis* (L.) Beauv. (Fig. 6). This is a weedy annual grass found in the autumn in various kinds of habitats. The stems may be simple, or branching near the base, and erect or slightly reclining. The leaves are rather short, broad, and have a short tuft of hairs (the ligule) at the junction of the leaf and the leaf-sheath (Fig. 6C). The dense, bristly, green or purplish heads are 2 to 3 inches long and produce many seeds. There are 1 to 3 greenish bristles at the base of each grain (Fig. 6E). The seeds are more or less oval, flat on one side, and have a slightly wrinkled or roughened surface and brownish spots on the rounded surface (Fig. 6G and Plate 17, no. 8).

Yellow Fox-Tail Grass, *Setaria glauca* (L.) Beauv., is very similar in its general appearance, but can be distinguished from the former species by the numerous long hairs extending up the leaf for some distance from the leaf-sheath (Fig. 6B). The bristles are also lighter in colour, and there are 5 to 20 in a cluster under the seeds (Fig. 6D). The seeds have many distinct ridges crosswise on the rounded surface (Fig. 6F and Plate 17, no. 7).

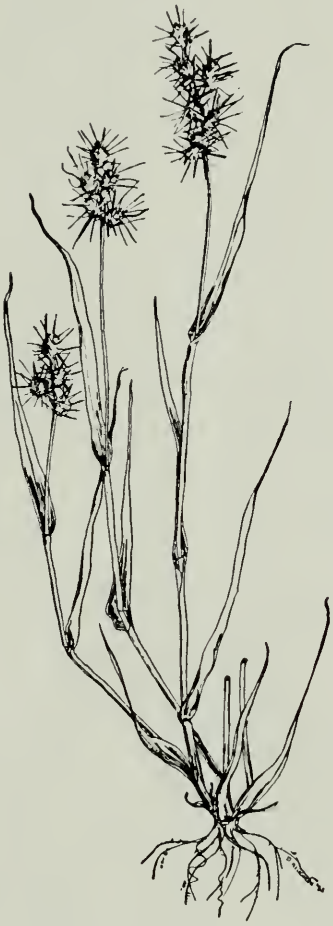

Fig. 7. Sandbur.

Sandbur, *Cenchrus longispinus* (Hack.) Fern. (Fig. 7). This annual occurs with some frequency in some parts of Ontario, particularly in sandy areas. The stems are branching, and more or less reclining. One has only to see or feel the prickly heads in order to know the plant. The single flower is surrounded by several hard, spiny bracts (Plate 17, no. 9), and these may cause painful injury if they get into an animal's mouth. Workers in tobacco fields and market gardens may find them quite annoying.

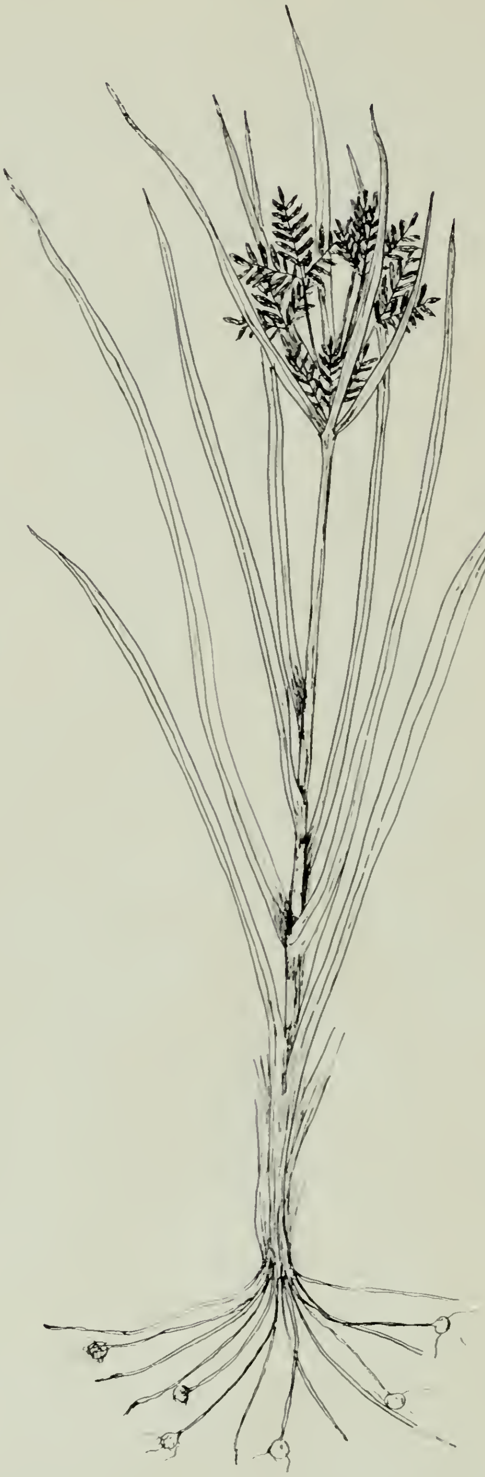

FIG. 8. Yellow nut-grass.

Yellow Nut-Grass, *Cyperus esculentus* L. (Fig. 8), is a perennial with the underground stems terminating in small tuberous structures from which new plants may arise. The presence of these make it a difficult weed to eradicate. The grass-like leaves are longer than the flower producing stem. The stem is triangular in cross-section. The flowers occur in an umbel-like cluster at the top of the stem, and are surrounded by a series of green leaves. The rather grass-like flowers are yellowish-brown.

In Essex, Kent and Elgin counties it is becoming a bad weed in low or moist cultivated ground. It occurs in a few other counties but to a lesser extent.

CURLED DOCK

RUMEX CRISPUS *L.*

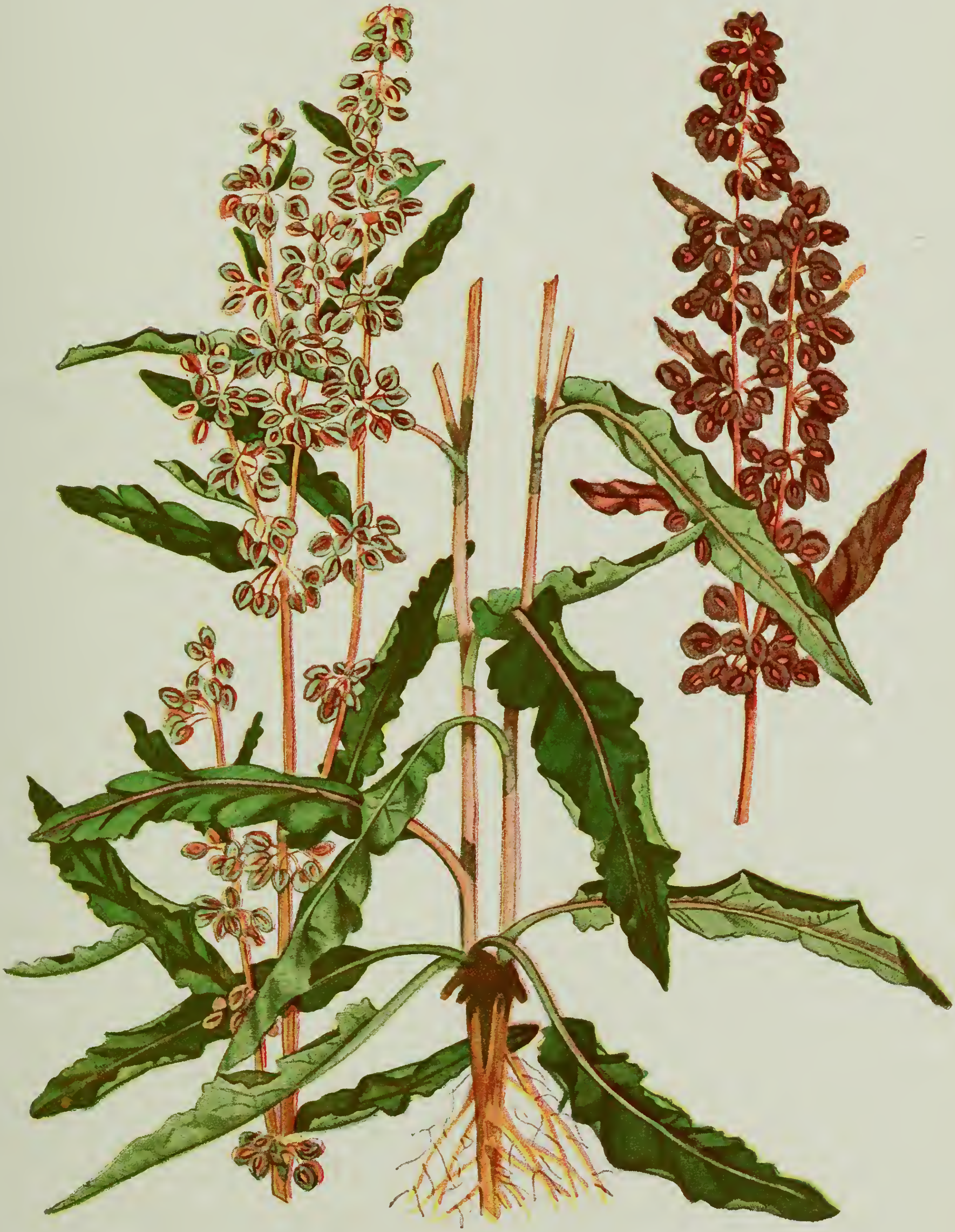

Plate 2. Curled dock.

THE BUCKWHEAT FAMILY (*POLYGONACEAE*)

Curled Dock, Sour dock, *Rumex crispus* L. (Plate 2). A perennial weed with a large, deep taproot and smooth, slender, striped stems with enlarged joints. It spreads by means of the numerous seeds. The alternate leaves are simple, narrow, pointed, and with curly or wavy margins. At the junction of the leafstalks (petioles) and the stem is a sheath, which is characteristic of the buckwheat family, to which the docks and the knotweeds belong. The flowers occur in clusters on branches from the axils of the stem-leaves. The smooth-margined seed coverings, which are at first green, turn brown as the seeds mature, and remain attached to the buckwheat-like, glossy, brownish seeds (Fig. 9A and B, and Plate 18, no. 2).

The life cycle of the rhubarb-curculio occurs on curled dock. Elimination of this dock is an essential for control of this insect. The melon-aphid is also found on dock.

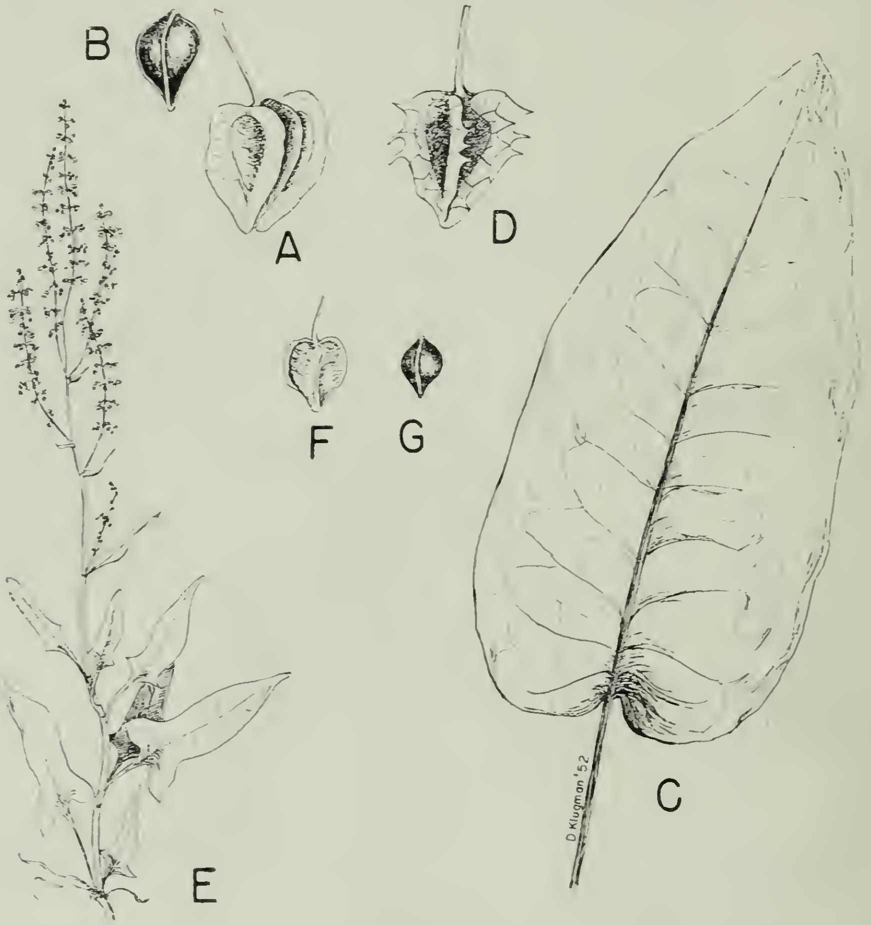

Fig. 9. A and B, Fruit and seed of curled dock. C, Leaf of broad-leaved dock. D, Fruit of broad-leaved dock. E, Sheep sorrel. F and G, Fruit and seed of sheep sorrel.

Broad-leaved Dock, Bitter dock, *Rumex obtusifolius* L., is distinguished from the curled dock by its large, broad, heart-shaped, smooth-margined lower leaves (Fig. 9C). Three of the divisions of the seed coverings have prominent teeth at their bases, and these are not present in the curled dock (Fig. 9D).

Sheep Sorrel, Sourgrass, *Rumex acetosella* L. (Fig. 9E), reproduces by both seeds and underground stems. This weed is much shorter than the two previous species, becoming only 1 to 1½ feet tall. The lower leaves have distinct projections or auricles. The flowers are small, and male and female flowers are on separate plants. The small, reddish-brown, glossy seeds usually remain enclosed in the roughened, brown seed-coverings (Fig. 9F and G, and Plate 18, no. 3).

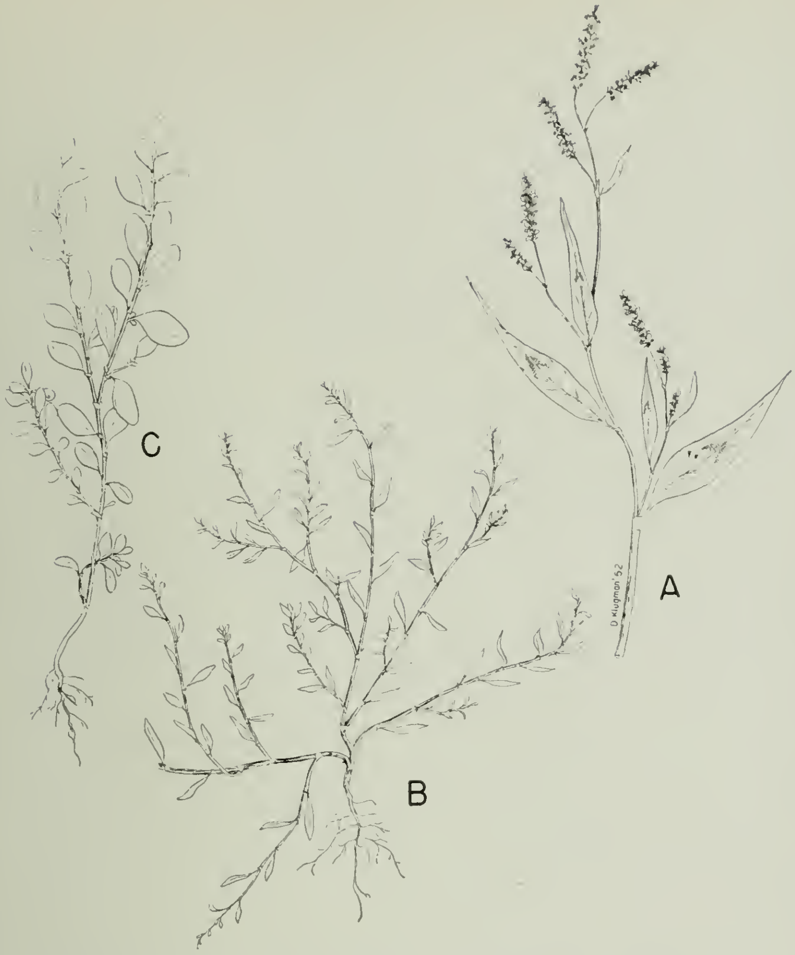

FIG. 10. A, Lady's thumb. B, Prostrate knotweed.
C, Erect knotweed.

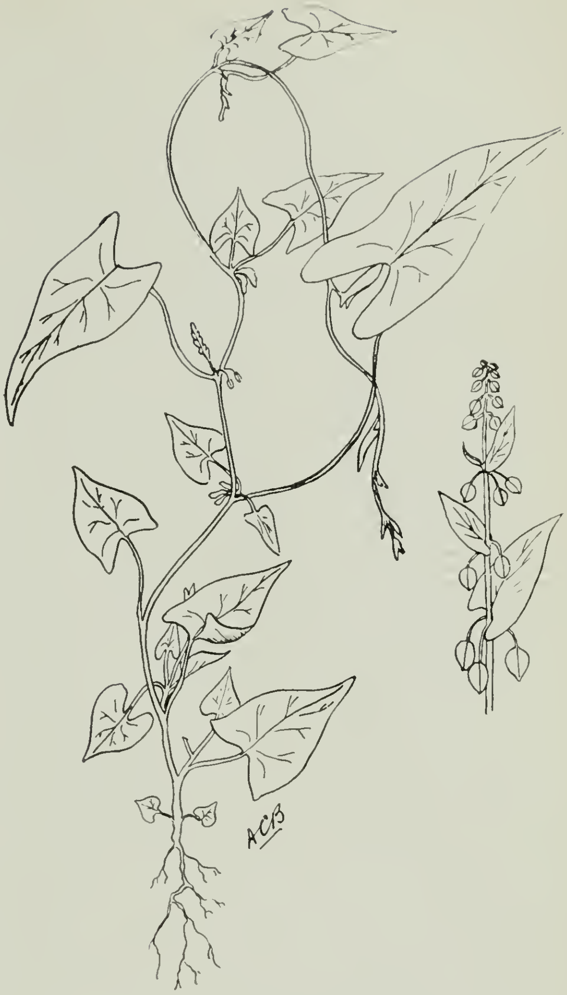

FIG. 11. Wild buckwheat.

Lady's Thumb, Spotted knotweed, *Polygonum persicaria* L. (Fig. 10A). This is a common plant in farmyards, cultivated ground, and roadsides. It is a smooth, erect plant with alternate leaves, also swollen joints and leaf-sheaths, which are characteristic of the buckwheat family. The leaves are long, more or less elliptical in outline, and usually each has a triangular dark spot in the centre of the blade. The flowers are pinkish and close together on a common stalk from the junction of the stem and leaves. The seeds are small, glossy, purplish-black, and more or less lens-shaped (Plate 18, no. 5).

Along paths, roadsides, and farmyards, where there is much tramping, the **Prostrate Knotweed,** *Polygonum aviculare* L. (Fig. 10B), and the **Erect Knotweeds,** *Polygonum erectum* L. and *Polygonum achoreum* Blake (Fig. 10C), are very common. These prostrate or partially erect annual or biennial plants have small and inconspicuous flowers at the junction of the stems and leaves. There is often a pinkish tinge to the margins of the coverings of the seeds.

Wild Buckwheat, Black bindweed, *Polygonum convolvulus* L. (Fig. 11). In summer and autumn this annual weed is found twining over fences, around grasses, and plants of cultivated fields and gardens. The leaves are alternate, simple, smooth-margined, heart- or arrow-shaped and pointed. The flowers are on long flower-branches from the junction of the leaf-stalk and stem. The outer seed-coverings are greenish with white or coloured margins. The seeds are buckwheat-shaped, slightly roughened, and black (Plate 18, no. 4).

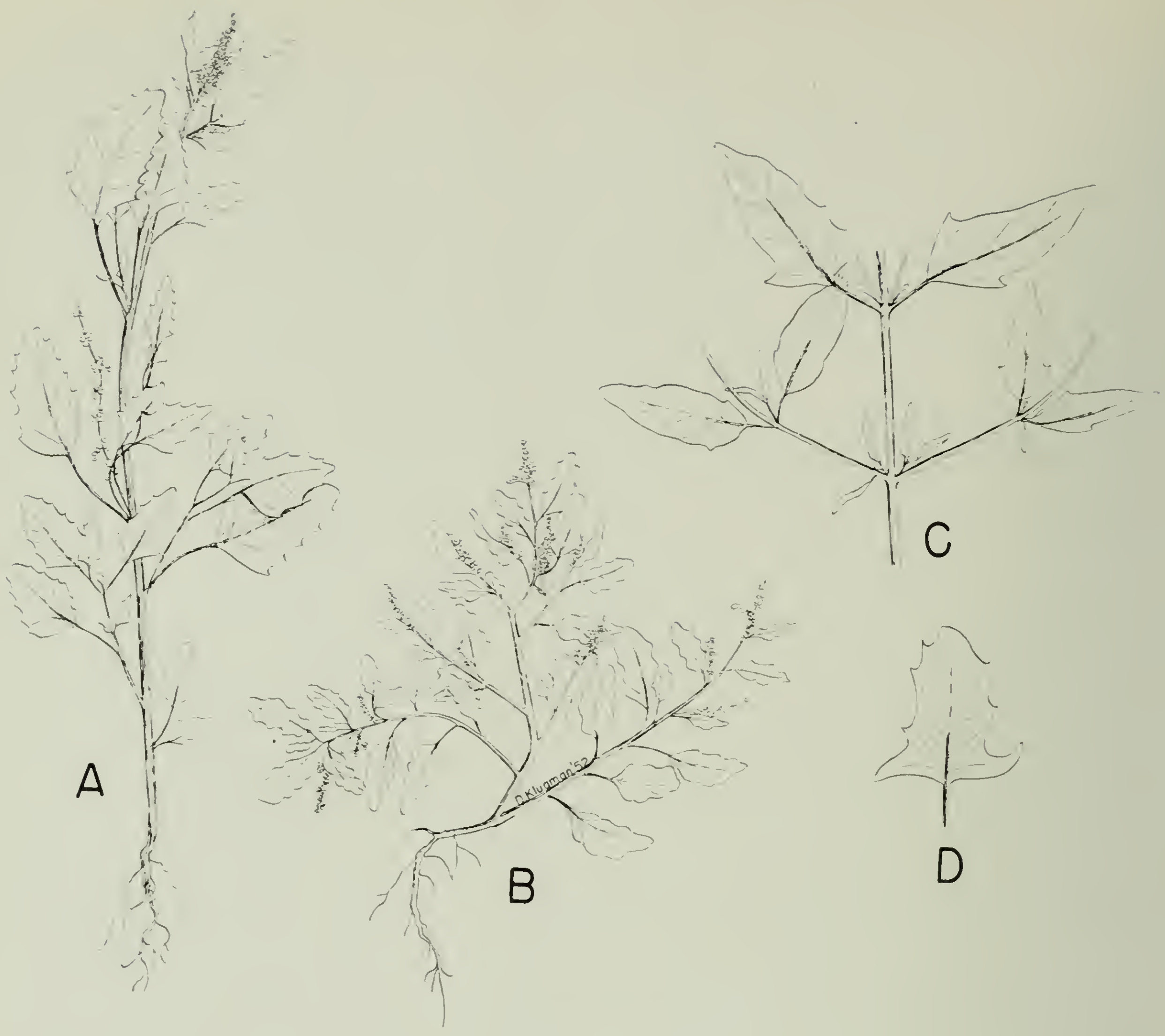

Fig. 12. A, Lamb's quarters. B, Oak-leaved goosefoot. C, Lower branches of spreading orache. D, Leaf of var. *hastata*.

THE GOOSEFOOT FAMILY (*CHENOPODIACEAE*)

Lamb's Quarters, *Chenopodium* sp. (Fig. 12A). Lamb's quarters is a common annual weed whose growth form is very variable. The stems are smooth and more or less purple-striped. The leaves have a whitish coating on the underside, and the margins are irregularly toothed. The greenish flowers are in clusters along a flowering-stalk originating at the junction of the stem and leaves. They are covered with the whitish particles which are typical of this plant. The seeds are shiny black, but commonly covered by a dull grey hull (Plate 18, no. 6).

Lamb's quarters is a host of the potato-aphid, spinach flea-beetle and spinach leaf-miner.

The **Oak-leaved Goosefoot,** *Chenopodium glaucum* L. (Fig. 12B). As the name implies, the leaf has a fancied resemblance to an oak leaf. The plant is low, and tends to spread over the ground. The stems are purple-striped, and the leaves have a whitish coating on the underside. The flowers have the same origin and appearance as in the preceding plant, but the flowering-stalks are much shorter. The seed is brownish in colour.

Spreading Orache, *Atriplex patula* L., and its variety *hastata* are often confused with lamb's quarters. The lower branches of orache, however, are nearly always opposite (Fig. 12C), and they never are in the lamb's quarters. The leaves are deep green and without the greyish coating on the under surface. The flowers lack the whitish particles, and the fruit appears triangular because of the bracts surrounding the seed (Plate 18, no. 7).

The variety *kastata* has broad, triangular and often toothed leaves, and they do not taper to the base, but are more or less square or slightly heart-shaped (Fig. 12D).

Russian Thistle, Saltwort, *Salsola kali* L. var. *tenuifolia* Tausch. (Fig. 13). This plant is low, bushy, hairy, and the stems are reddish-striped. The leaves are short, narrow, and sharp-pointed. The flowers are very small, green or pinkish and are in the axils of the leaves. The plant produces enormous numbers of seeds. In the fall the plants break off at the surface of the ground and are carried away by the wind, thus scattering the seeds. The seed (Plate 18, no. 9) is spiralled within its coating somewhat like a snailshell.

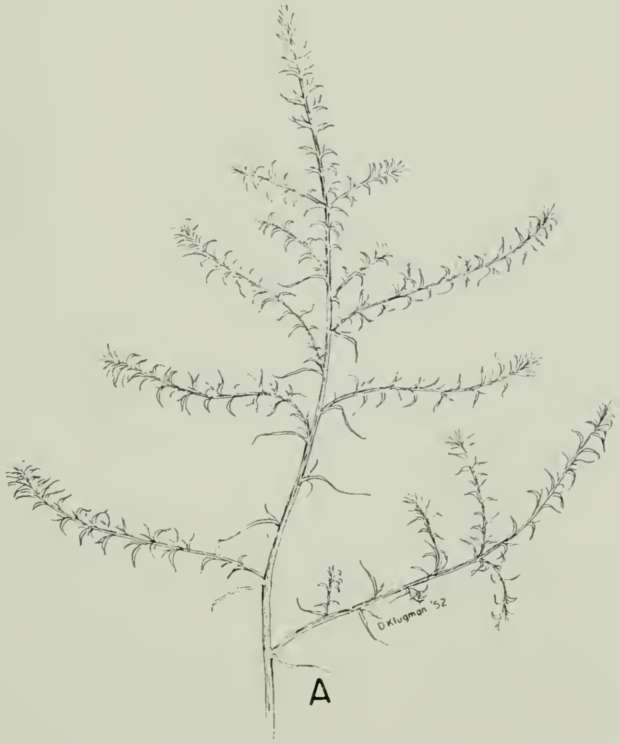

Fig. 13. Russian thistle.

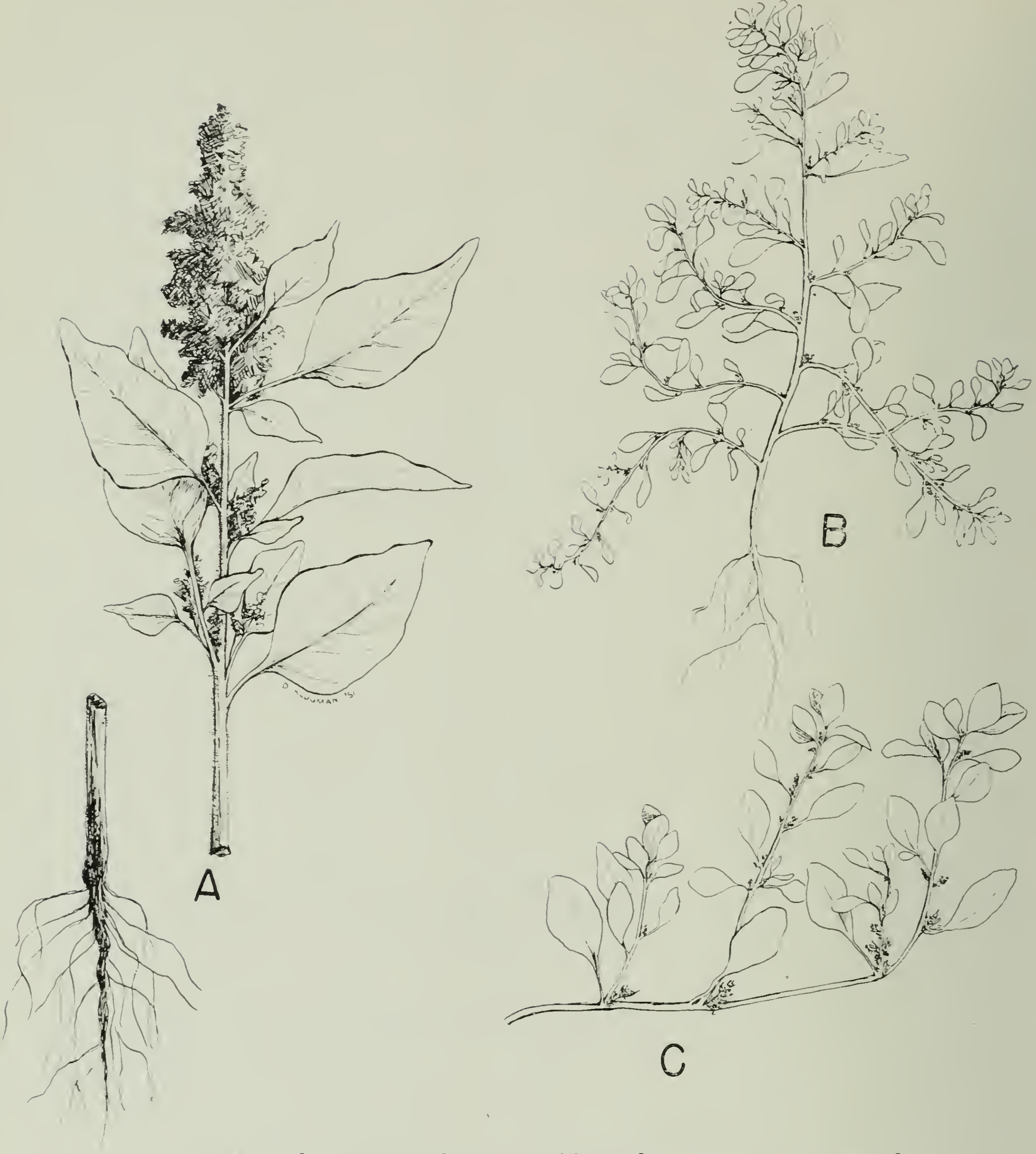

FIG. 14. A, Redroot pigweed. B, Tumbleweed. C, Prostrate pigweed.

Redroot Pigweed, *Amaranthus retroflexus* L. (Fig. 14A). This is a common annual weed in cultivated ground. The seeds may withstand long burial in the soil and germinate when the proper growing conditions are again presented. The top of the rather large root is red or pinkish. The stem is tall, much branched, rough and hairy. The leaves have long leaf-stalks, and the broad blades have a somewhat wavy margin. The flowers are small and grouped in dense clusters where the upper leaves join the stems. The numerous seeds are glossy-black, lens-shaped and with a narrow, thin margin (Plate 18, no. 10).

Green Amaranth, *Amaranthus hybridus* L., is similar in many respects to redroot pigweed but is smoother, deeper green, and the flowering branches are more spreading.

Tumbleweed, *Amaranthus albus* L. (Fig. 14B), is not as tall as the former species, but is much more branching and spreading. The stems are light green, and the leaves are broad at the tips and taper down to the leaf-stalk. The flowers are in small clusters where the leaves join the stem. In fall the plant may break off close to the ground and scatter its seeds as it is carried along by the autumn winds.

Prostrate Pigweed, *Amaranthus graecizans* L. (Fig. 14C), is often confused with tumbleweed, which it closely resembles. However, it spreads widely over the surface of the ground, and the stems may be purplish in comparison with the greenish-white stems of the tumbleweed.

The eradication of the pigweeds is important in the control of the spinach flea-beetle, tarnished plant-bug and spinach leaf-miner which find these plants suitable hosts.

THE PURSLANE FAMILY (*PORTULACACEAE*)

Common Purslane, Pusley, *Portulaca oleracea* L. (Fig. 15), is a prostrate annual with thick, smooth, fleshy leaves. It is branching, and often forms a dense mat on the ground. The stems are smooth and reddish. The small, yellow flowers develop in the axils of the leaves. The seed-capsules contain many flat, oval, black, rough-looking seeds (Plate 18, no. 11).

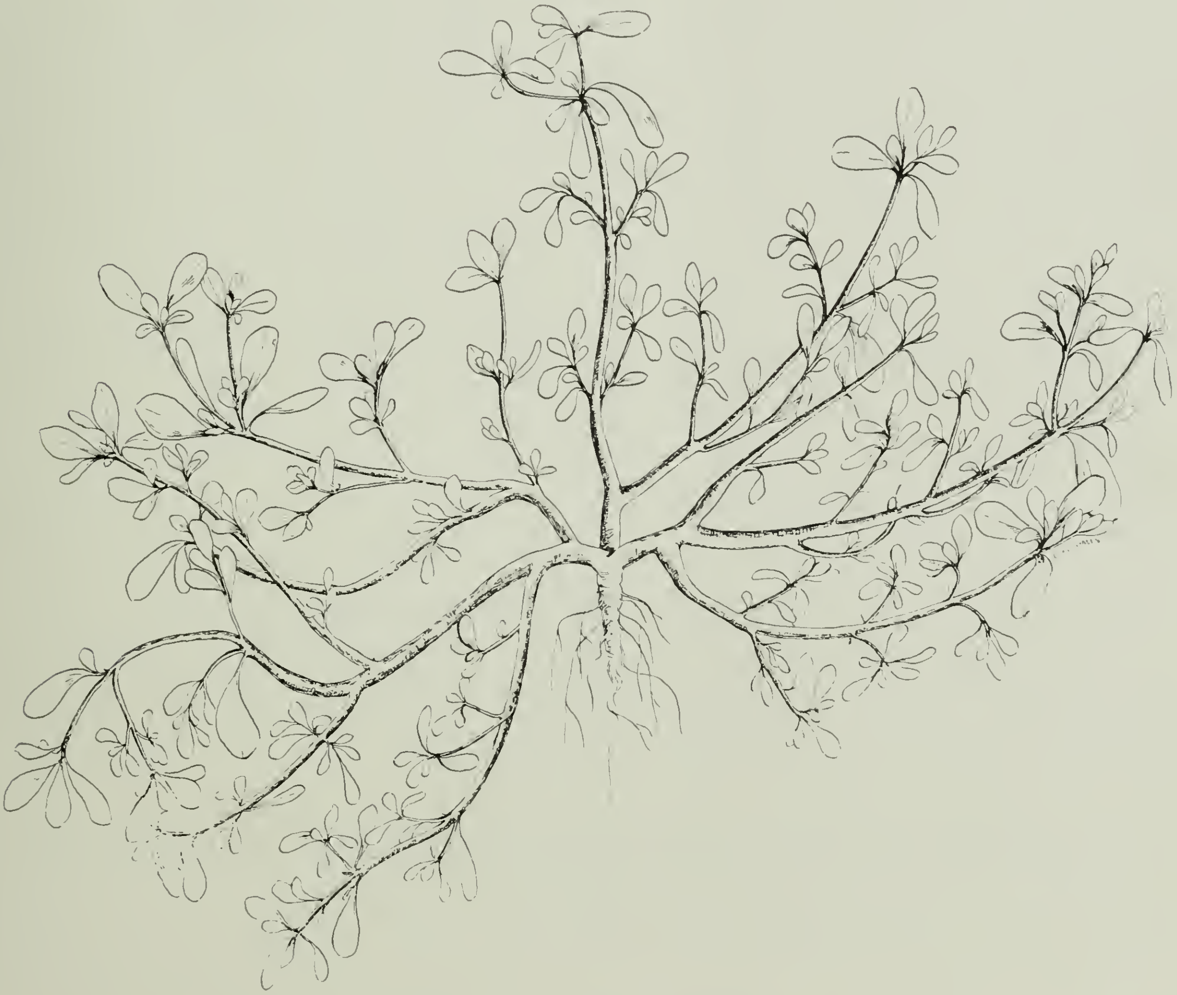

Fig. 15. Common purslane.

Because of its fleshy nature, it may live for some time and ripen seeds even after hoeing or pulling it out of the ground. It is very troublesome on rich garden land and muck soils.

THE PINK FAMILY (*CARYOPHYLLACEAE*)

Common Chickweed, *Stellaria media* L. (Fig. 16A), is a tender, low-lying matted plant, with small, star-like flowers (Fig. 16B) appearing from early spring to late fall. The opposite leaves are rather oval-shaped, and are comparatively long-stalked. The plant is a hardy annual, and may reproduce by seed or by rooting at the joints of the stems. The seeds are very small, and dull, reddish-brown in colour (Plate 18, no. 13).

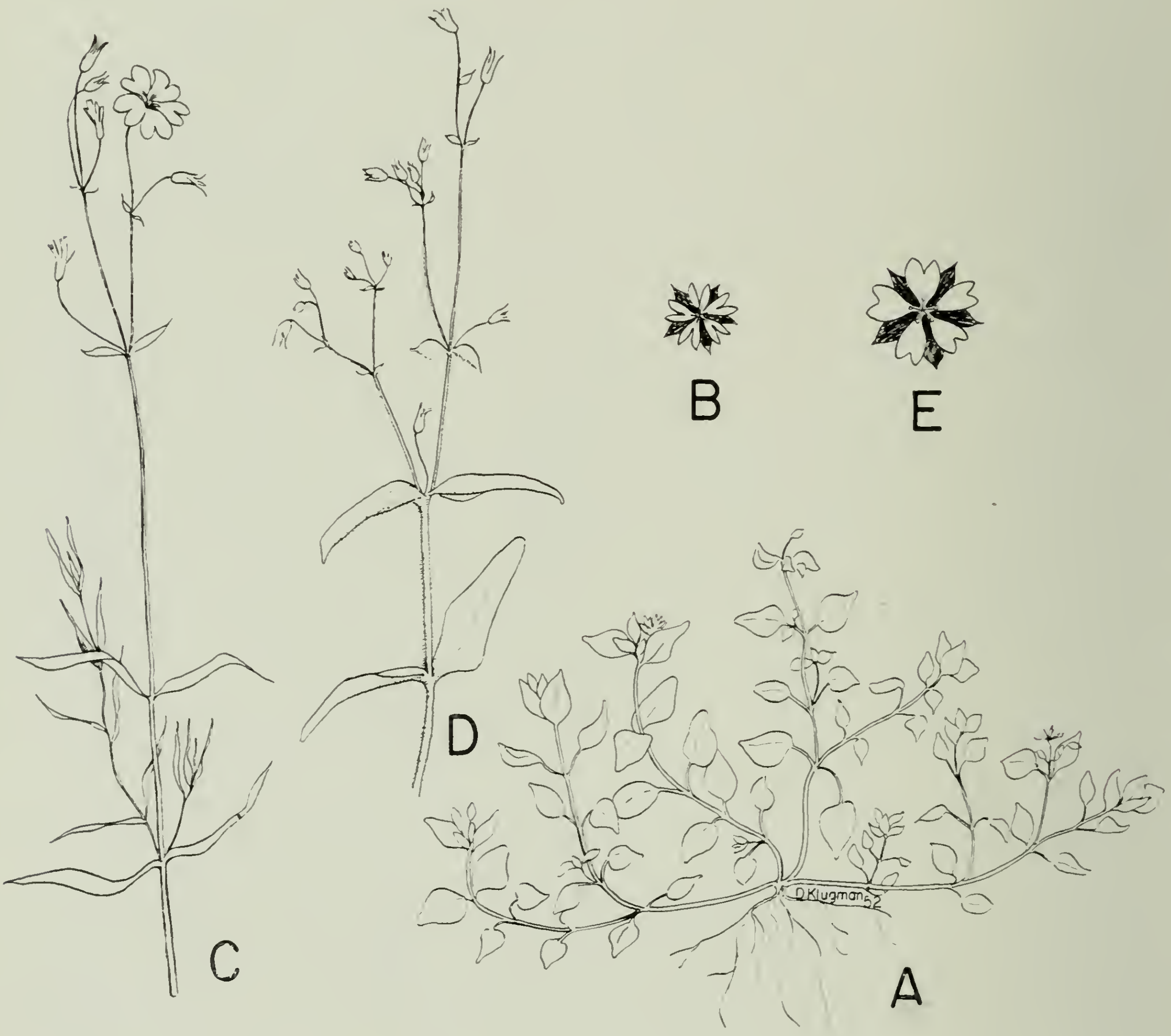

FIG. 16. A, Common chickweed. B, Flower. C, Field chickweed. D, Mouse-ear chickweed. E, Flower.

Mouse-Ear Chickweed, *Cerastium vulgatum* L. (Fig. 16D), is a perennial. It has more or less oblong, densely-hairy leaves placed far apart on the stems. The upper leaves are without leaf-stalks. The petals are about the same size as the green bracts below them (Fig. 16E), and the seed-pods are long and curved at maturity. The seeds are brownish, more or less triangular and with small tubercles (Plate 18, no. 14).

The spinach leaf-miner is commonly found on the chickweeds.

Field Chickweed, *Cerastium arvense* L. (Fig. 16C). A perennial, with upright, very branching stems, and narrow, pointed leaves clustered near the base of the plant. The flowering branches are on long, almost leafless stalks. The white flowers are about 1 inch across, and the petals are longer than the green bracts beneath them.

Bladder-Campion, *Silene cucubalus* Wibel. (Plate 3), is a perennial, spreading by seed and shoots from the deep, wide-spreading crown. The whole plant is smooth with a whitish bloom (glaucous). The opposite, smooth leaves are more or less elliptical, and have no leaf-stalk. The most interesting part of the plant is the pinkish or greenish-white, much veined, bladdery-calyx surrounding the white, or sometimes pinkish petals. The seed-pod is much smaller than the calyx and enclosed within it. Seed (Plate 19, no. 2).

White Cockle, *Lychnis alba* Mill. (Plate 4). A biennial or short-lived perennial, with the typical swollen joints and opposite leaves of the pink family. The plant is dark green and hairy, tall and branching. When the plants are in bloom, it is observed that some plants have only male flowers (staminate), while others have only female flowers (pistillate). The petals are white, or sometimes pinkish. The seed-pods become much inflated, filling the calyx when mature. When the pods split open, they have 10 teeth. Seed (Plate 19, no. 1).

Night-Flowering Catchfly, Sticky cockle, *Silene noctiflora* L., is usually an annual, and has the same general plant characteristics as the white cockle, but it has many sticky hairs covering the stems, leaves and flowers. The petals are white, and both sexes are present in the same flower. The pods are similar to the white cockle, but usually have only 6 teeth when they burst open. The seeds (Plate 19, no. 4) are similar to the white cockle, but are slightly darker in colour.

Purple Cockle, *Agrostemma githago* L., may be of local occurrence in the province. Its densely-hairy stems and leaves, rather large purple flowers and long calyx lobes are characteristic features. Purple cockle seeds may sometimes be found in feed grain. These are injurious to poultry. Seed (Plate 18, no. 15).

Bouncing-Bet, Soapwort, *Saponaria officinalis* L. (Fig. 17), is a common plant along roadsides, and occasionally in fields. It is a perennial which develops in clumps. All parts of the plant are smooth. The calyx is much more slender and tube-like than that of the cockles. The flowers are pinkish or rose coloured. Seed (Plate 19, no. 5).

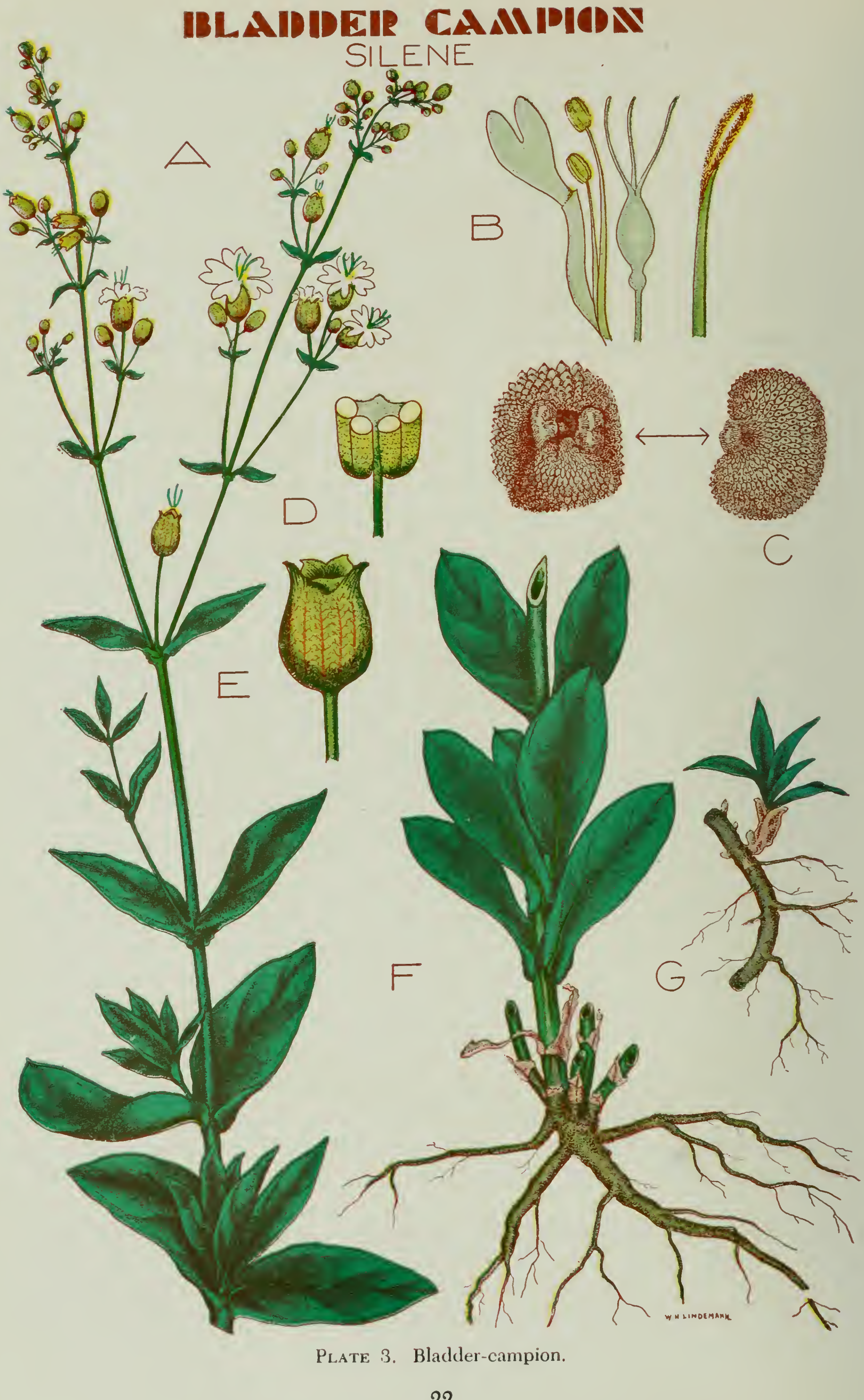

Plate 3. Bladder-campion.

WHITE COCKLE

LYCHNIS ALBA

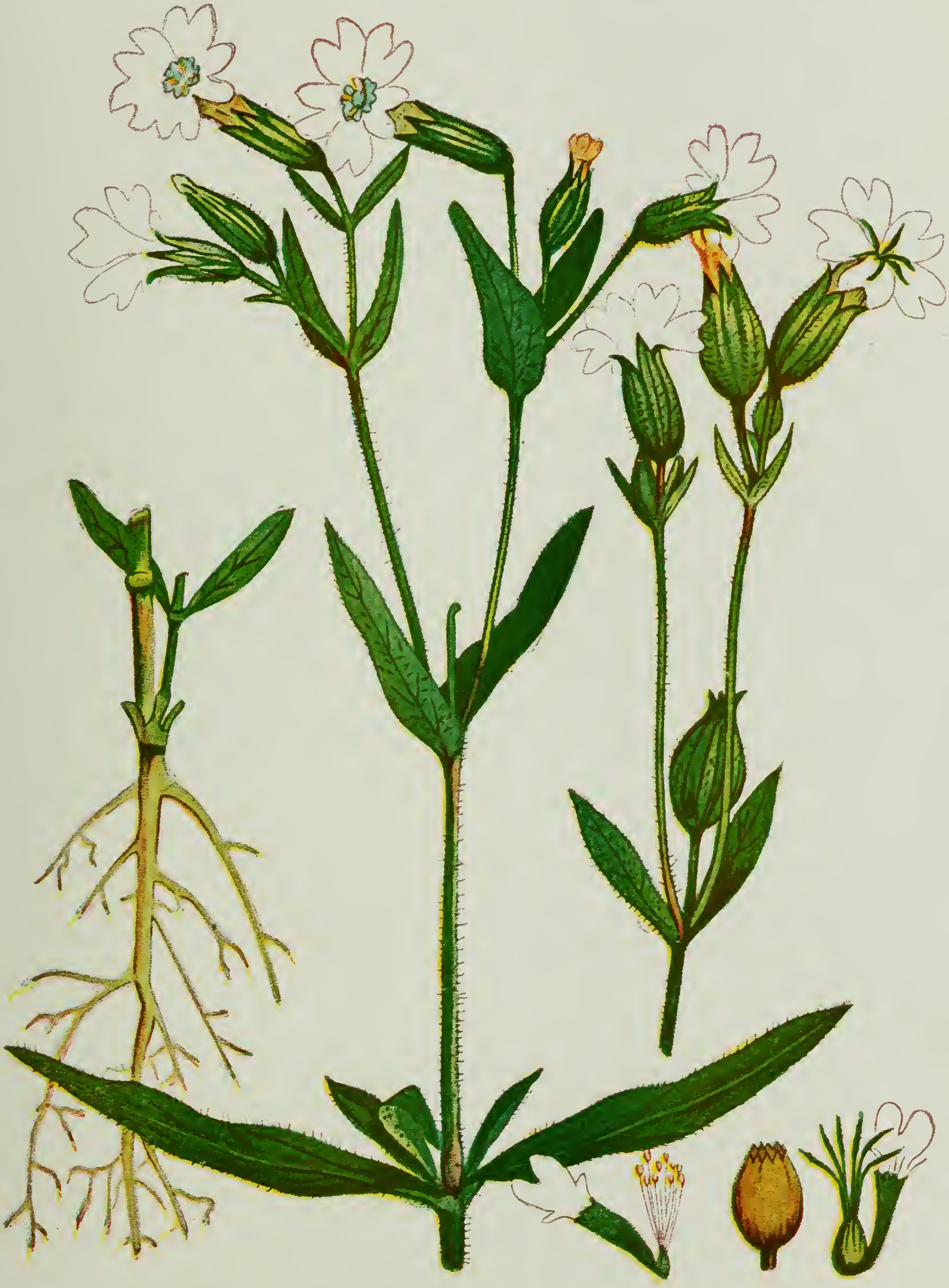

PLATE 4. White cockle.

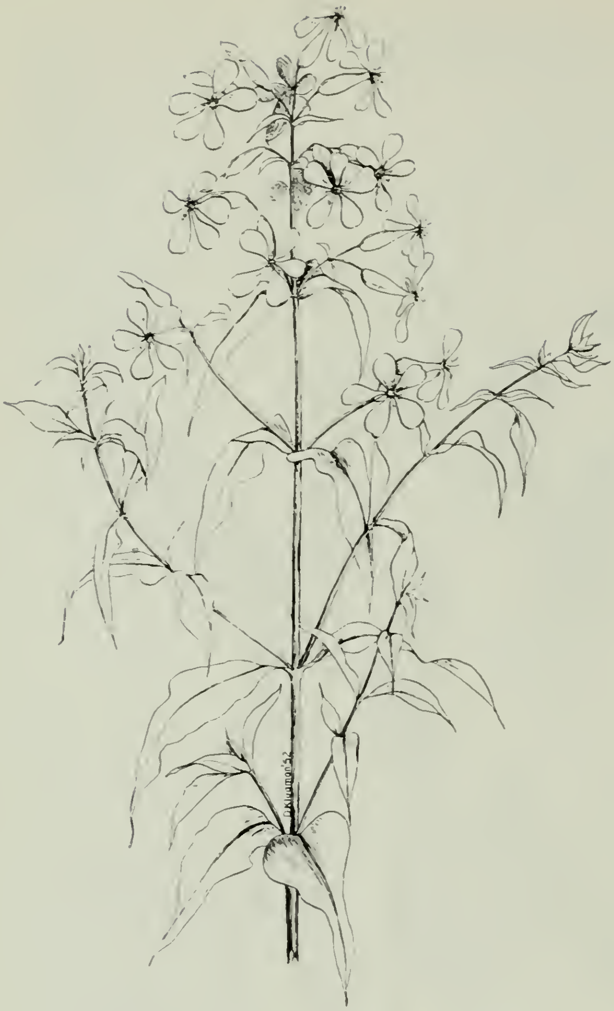

FIG. 17. Bouncing-bet.

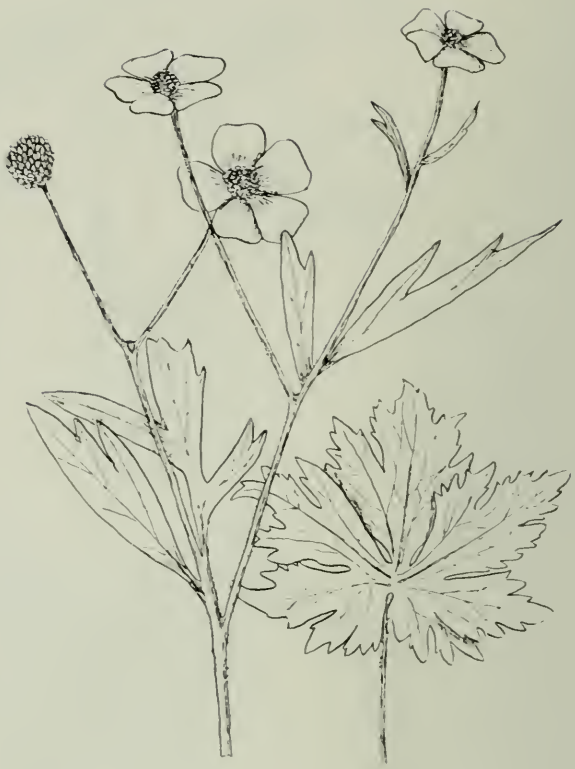

FIG. 18. Tall buttercup.

THE BUTTERCUP FAMILY (*RANUNCULACEAE*)

Buttercups are not usually persistent in cultivated ground. The pretty, deep-yellow flowers of the **Tall Buttercup,** *Ranunculus acris* L. (Fig. 18), are a common sight in pastures and deserted land, particularly if the soil is moist. Fruit (seed) (Plate 19, no. 7).

The small **Creeping Buttercup,** *Ranunculus repens* L., is often a pest in lawns and gardens. It has numerous fibrous roots, and the stems creep along the ground, rooting at the nodes. The flowers and leaves are similar to the common buttercup.

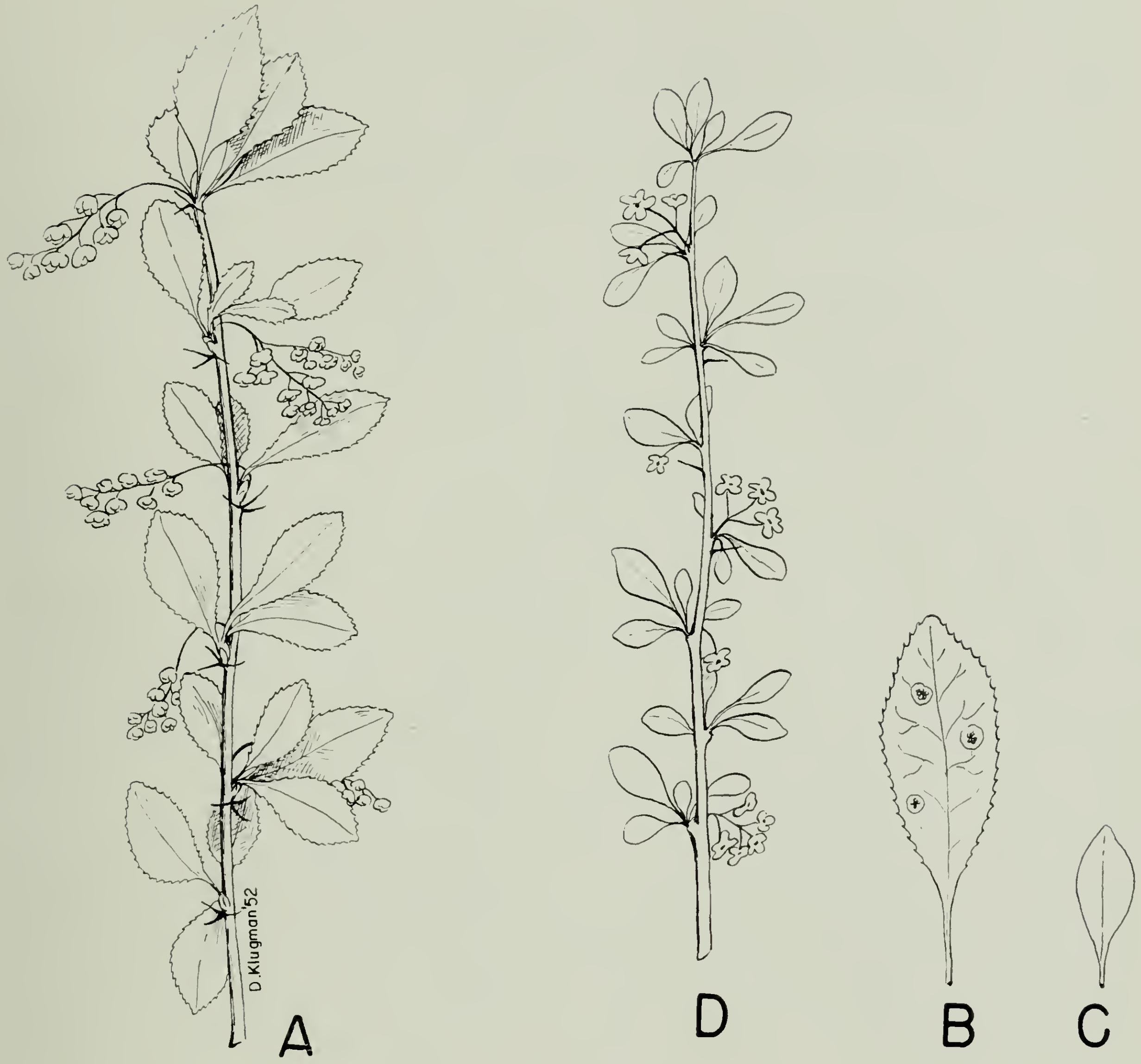

Fig. 19. A, Twig of common barberry. B, Leaf showing cluster cups of stem rust. C, Single leaf of Japanese barberry. D, Twig of Japanese barberry.

Common Barberry, European barberry, *Berberis vulgaris* L. (Fig. 19A), is a perennial shrub 3 to 8 feet high, and reproducing by seeds and by shoots from the wide-spreading roots. The alternate leaves are broader at the tips than at the bases, and have finely-toothed margins with the teeth terminating in short spines. The leaves are grayish-green beneath. On some of the younger branches these leaves may be reduced to 3-parted spines. The numerous, yellow flowers hang in long clusters (racemes) from the axils of the leaves. By autumn these flowers have matured to bright red, elliptical berries.

The barberry is important as a host-plant for one of the stages of the stem-rust of grain, and it should therefore be eradicated. Fig. 19B shows the underside of a barberry leaf with cluster cups of this stage of the rust.

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The **Japanese Barberry**, *Berberis thunbergii* DC. (Fig. 19D), should not be confused with the common barberry and is *not* a host plant for the stem-rust. It can be distinguished by its smaller leaves with smooth margins, and the spines are only 1-pronged instead of three. The flowers vary from 1 to 5 in a cluster (umbel) at the end of a single stalk.

THE MUSTARD FAMILY (*CRUCIFERAE*)

Pennycress, Stinkweed, *Thlaspi arvense* L. (Fig. 20), is a winter annual with a branching taproot, and with simple or branching, smooth stems, 8 to 24 inches high. The lowest leaves have long leaf-stalks and smooth margins. The upper leaves have no leaf-stalks, but are attached directly to the stem at the arrow-shaped base, and have toothed margins. The flowers are numerous, small and white. The seed-pods are oval and flat, about one-half inch in diameter with large wings and a rather deep U- or V-shaped notch at the upper end. They stand erect, and almost parallel to the stem. Seed (Plate 19, no. 9).

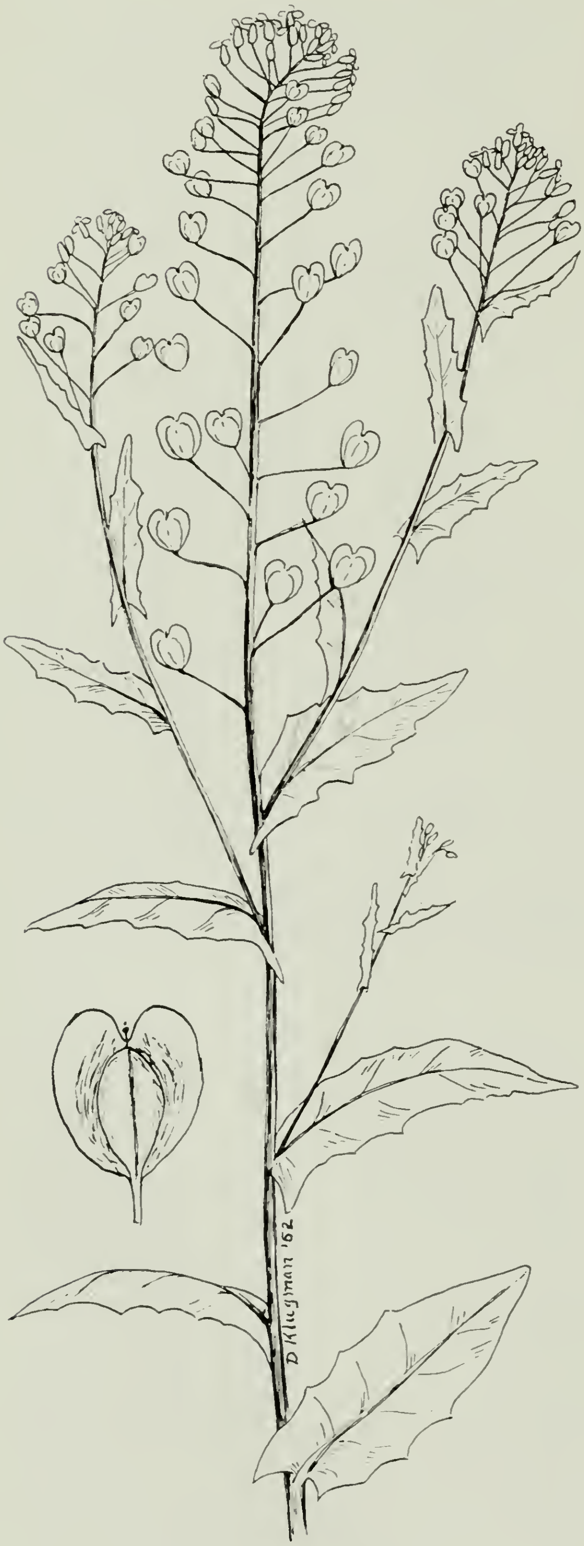


Fig. 20. Pennycress.

Field Peppergrass, *Lepidium campestre* R. Br. (Fig. 21A), is a biennial found commonly in cultivated ground, roadsides and waste places. In the fall the plant has a rosette or cluster of stalked, deeply-lobed or toothed leaves close to the ground. In spring one or more very leafy stems form. The stem-leaves may be parallel-sided and pointed, or broader at the bases than at the tips; the margins are toothed, and the leaves are attached to the stem by an arrow-shaped clasping base. Both the stems and leaves have short, fine hairs. The numerous, small, white flowers have short stalks, and are distributed along the stem for some distance (racemes). The seed-pods are oval, boat-shaped (rounded below, and hollowed out above) about one-quarter inch long with a small notch at the end, and a slightly winged margin. Seed (Plate 19, no. 10).

Common Peppergrass, *Lepidium densiflorum* Schrad. (Fig. 21B), is a winter annual. The basal leaves are coarsely toothed, and the plant often has a bushy appearance. The stem-leaves are not as crowded as in the previous species, and they are toothed only near the tips. The flowers are small, have no petals, and usually only two stamens. The seed-pods are about half the size of the field peppergrass, but are flat. Seed (Plate 19, no. 11).

The peppergrasses are known to be a host of the melon-aphid.

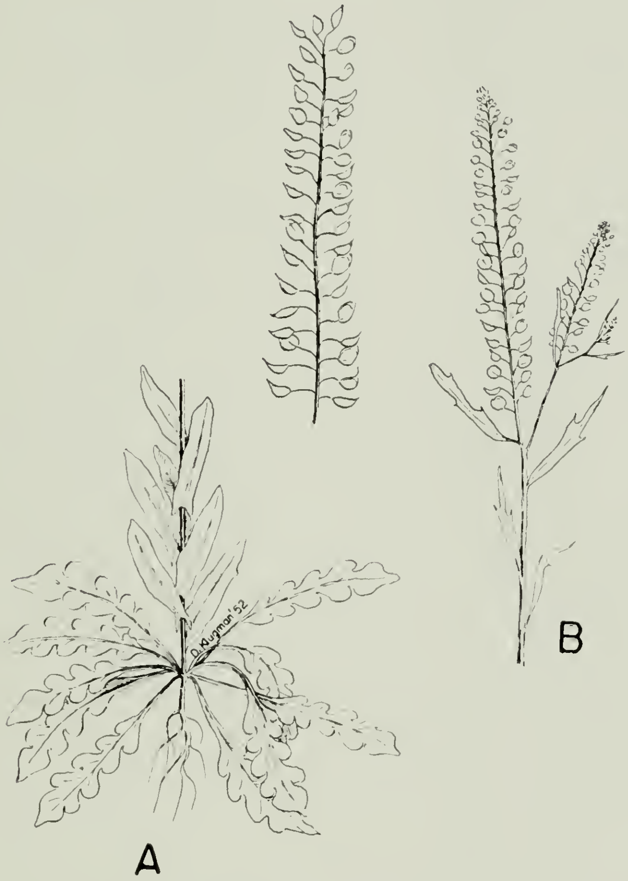


Fig. 21. A, Field peppergrass. B, Common peppergrass.

Shepherd's Purse, *Capsella bursa-pastoris* (L.) Medic. (Fig. 22). A very common, widely distributed winter annual. On the ground is found a rosette of leaves which may vary considerably in form, but most frequently they are lobed. The slender stems are from a few inches to 18 inches high. The stem-leaves are slender, arrow-shaped, without leaf-stalks, and often clasping the stem. The flowers are small and white, and the plant keeps blooming for a long time. The seed-pods are small, heart-shaped, or, as the name implies, purse-shaped, with the stigmas forming the little purse fasteners. Seed (Plate 19, no. 13).

Shepherd's purse is known to harbour the melon-aphid and the potato-aphid.

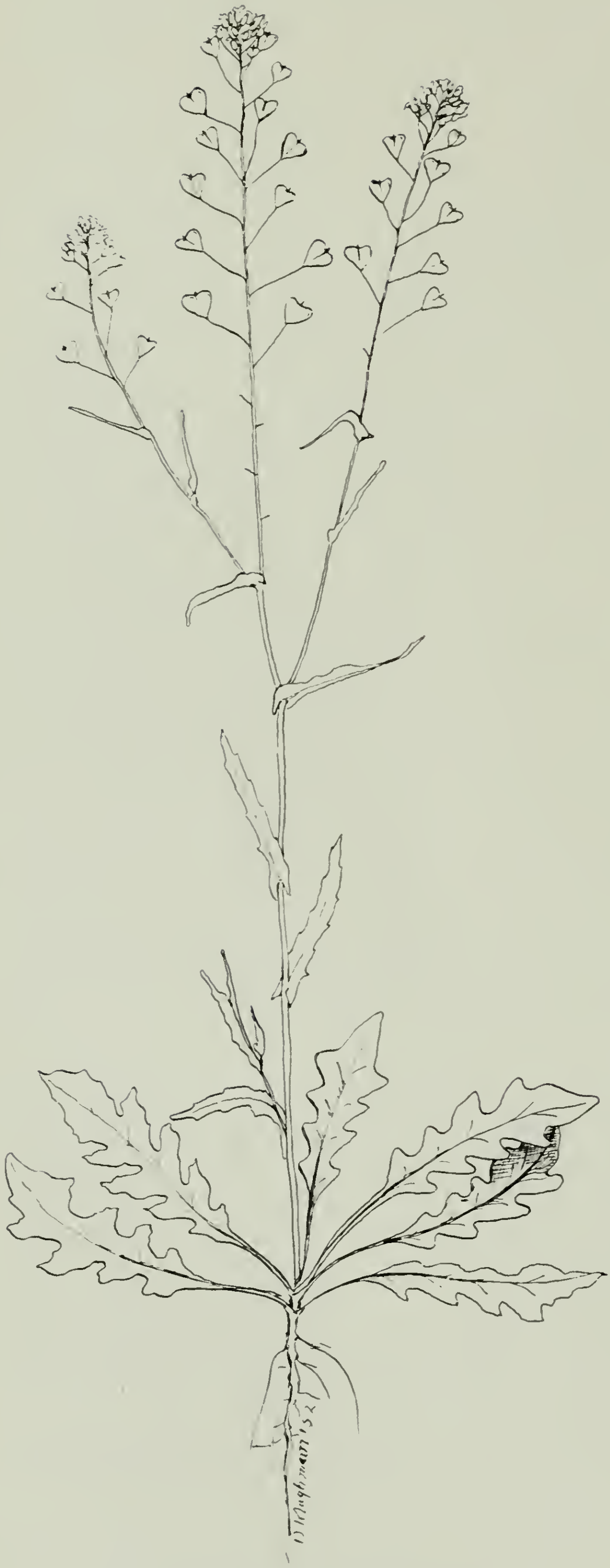


Fig. 22. Shepherd's purse.

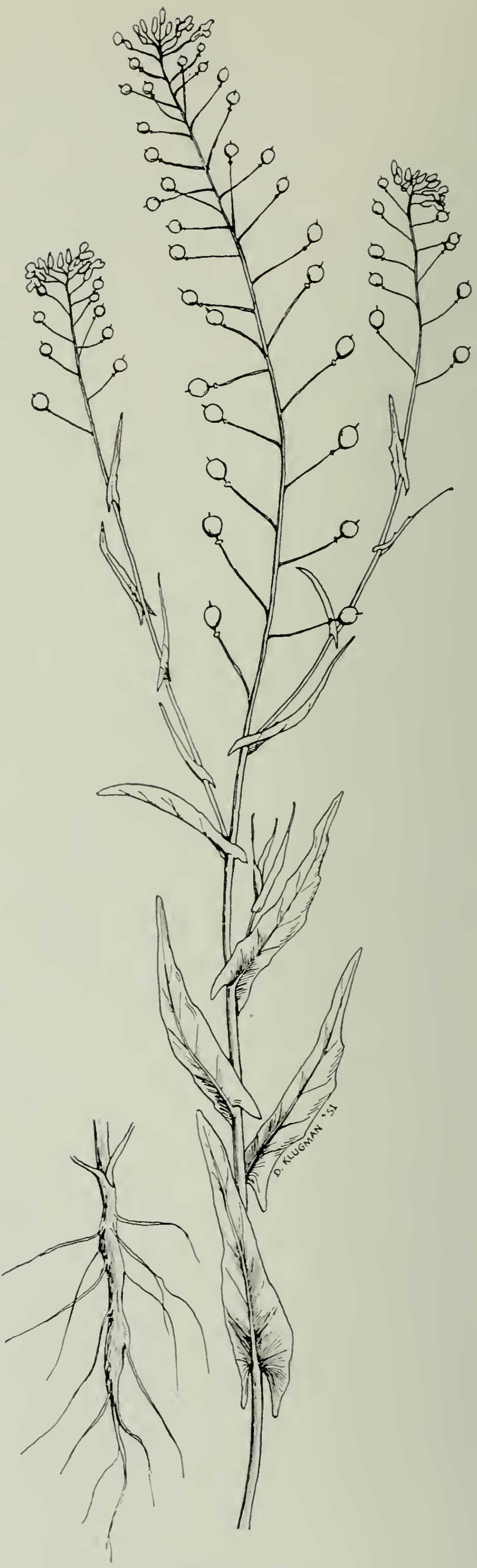


Fig. 23. Small-seeded false flax.

Small-seeded False Flax, *Camelina microcarpa,* Andrz. (Fig. 23). This frequent inhabitant of grainfields is a rather tall biennial. The lower leaves are long-elliptical with wavy-toothed margins. The upper leaves are smaller, wavy-margined, arrow-shaped and almost clasping the stem by the heart-shaped base. The lower part of the stem and the leaves have numerous stiff hairs, which when seen through a lens are observed to be forked. The flowers are small, yellow, and the seed-pods are oval, with a prominent margin and a point on the outer end. The pods contain several seeds. Seed (Plate 19, no. 14).

This plant may be confused with the **Large-seeded False Flax,** *Camelina sativa* (L.) Crantz, which has larger seed-pods and larger seeds (Plate 19, no. 15): Also with **Ball Mustard,** *Neslia paniculata* (L.) Desv. which has star-shaped hairs, and the one-seeded pods have very distinct network-like markings (Plate 19, no. 16).

Wild Mustard, Charlock, *Brassica kaber* (DC.) L. C. Wheeler var. *pinnatifida* (Stokes) L. C. Wheeler (Fig. 24), is a much branched, rough, hairy-stemmed annual. The lower leaves are deeply dissected or lobed. The upper ones are not lobed, but coarsely toothed and the leaf-stalks are very short. The flowers are light yellow and comparatively large. The smooth, or almost smooth seed-pods are quite distinctive with their knotty appearance and angular beak about one-third the length of the pod. This beak usually contains a seed. Seed (Plate 20, no. 1).

Indian Mustard, *Brassica juncea* Cosson, is a winter annual with a slight whitish cast or bloom on the stem and leaves. The lower leaves are lobed and somewhat hairy, but the upper are not lobed, and taper toward the base, and may be without hairs. The margin of the upper leaves may be wavy or have shallow, blunt lobes. The seed-pods are 1 to 3 inches long, and have a prominent beak about one-quarter the length of the pod. There is no seed in the beak such as in the wild mustard. Seed (Plate 20, no. 2).

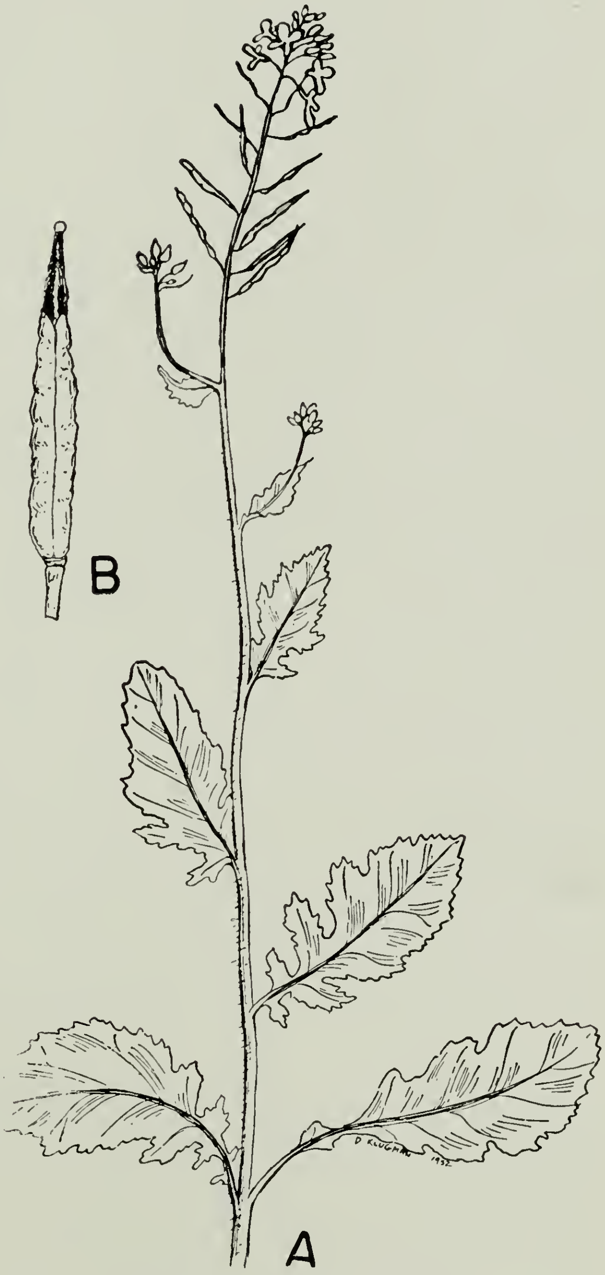


Fig. 24. Wild mustard.

Mustards are hosts to the imported cabbage-worm, cabbage-looper, cabbage-aphid, and the striped flea-beetle. The common mustard is a frequent host for the turnip-beetle. Early in the season this insect develops on common mustard and later infests the turnip crop.

Hedge Mustard, *Sisymbrium officinale* var. *leiocarpum* DC. (Fig. 25), is an annual weed with branching, roughened stems. The leaves are coarsely lobed, and the lobes are toothed. The deep yellow flowers are close together along the upper branches. The smooth pods lie close to the branches, and are sharply pointed. Seed (Plate 20, no. 6).

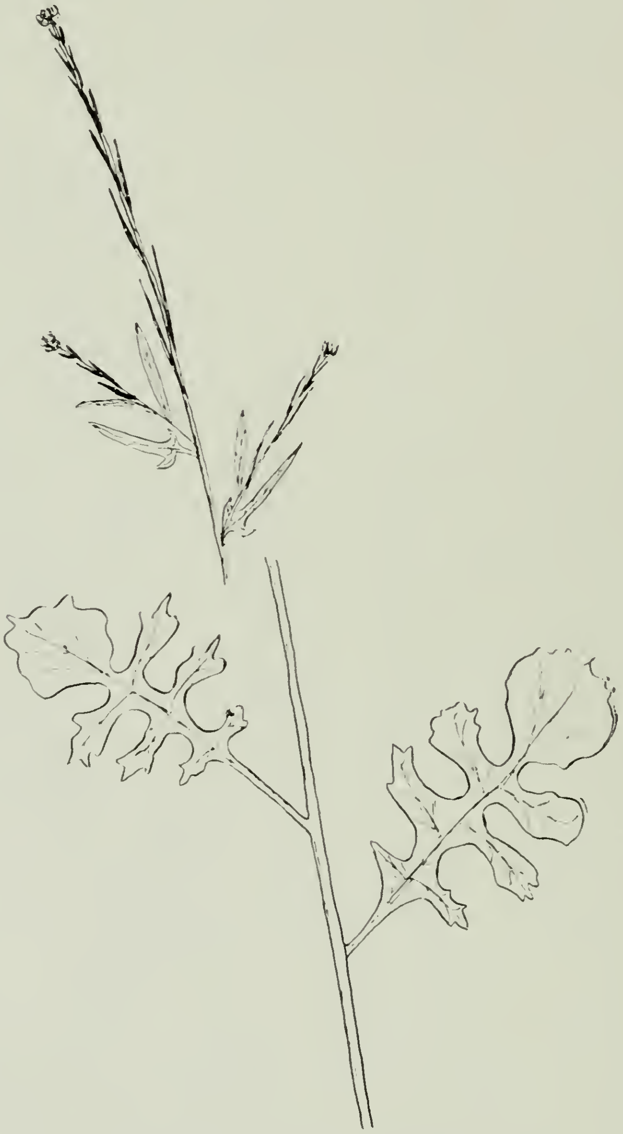


Fig. 25. Hedge mustard.

Tumbling Mustard, *Sisymbrium altissimum* L. (Fig. 26). An annual or winter annual. The plant height may vary from 1 to 4 feet, and it may be single-stemmed or quite branching. The stem is light green in colour and hairy, particularly at the base. The lower leaves are large, and cut into large segments, but the upper leaves are very finely divided. The flowers are light yellow, and the seed-pods are long, narrow and spreading. Seed (Plate 20, no. 7). In the West when the plants are mature, they break off at the base and roll over the ground distributing the seeds.

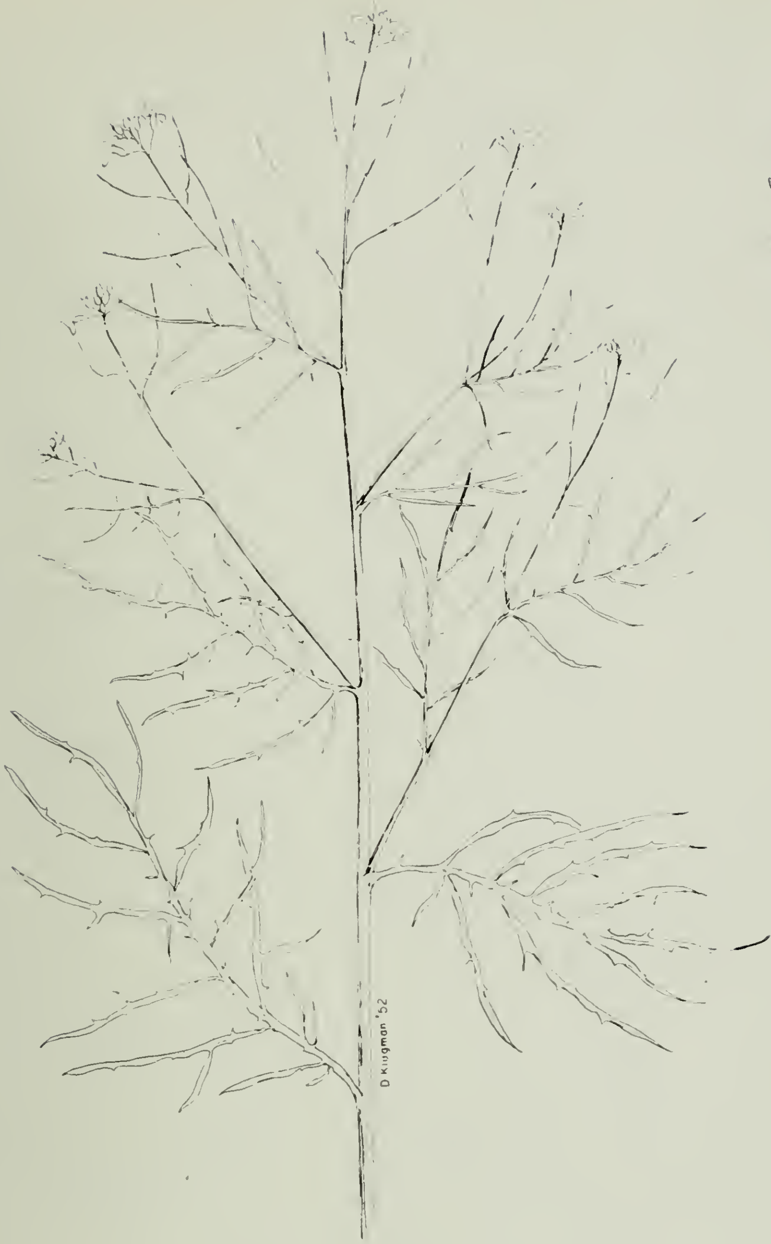


Fig. 26. Tumbling mustard.

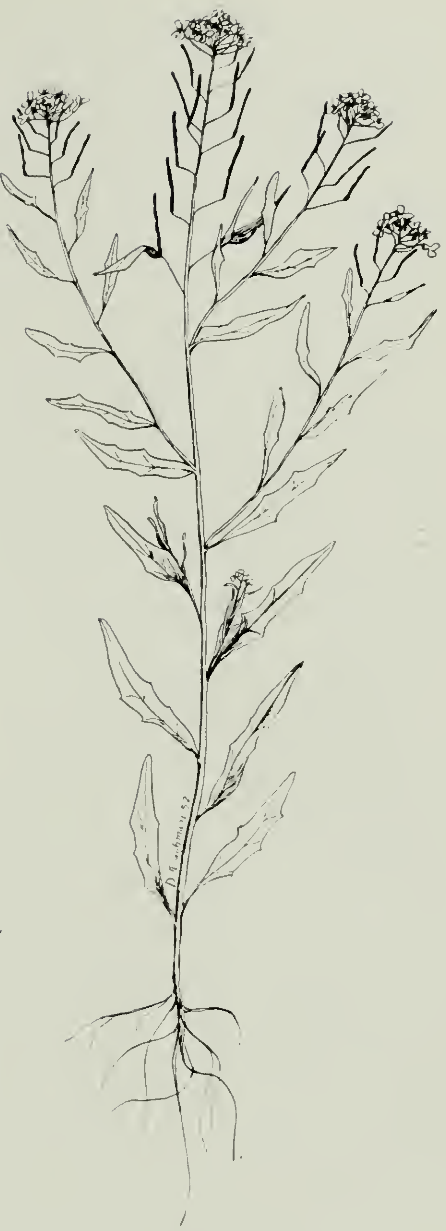


Fig. 27. Wormseed mustard.

Wormseed Mustard, *Erysimum cheiranthoides* L. (Fig. 27), is a winter annual, flowering from spring till fall. It may be single-stemmed or branching. The leaves are elliptical, with short leaf-stalks or none, and roughened by 3-pronged hairs. The whole plant may have a slightly grayish colour. The flowers are small, yellow and on thin stalks. The seed-pods are about 1 inch long, somewhat four-sided. Seed (Plate 20, no. 9).

A very similar looking mustard, *Erysimum hieracifolium* L., is also found, particularly in some eastern counties. It is a biennial or perennial, with mostly four-pronged hairs on the upper surface of the leaf. The petals are a little larger and lighter yellow in colour. The seed-pods lie close to the stem.

Flixweed, *Descurainia sophia* (L.) Webb., is an annual or biennial weed. It is a simple or much branched plant with finely divided, grayish-green leaves. The flowers are small, and the petals are greenish-yellow. The seed-pods are very slender and 1 inch or more long. Seed (Plate 20, no. 8).

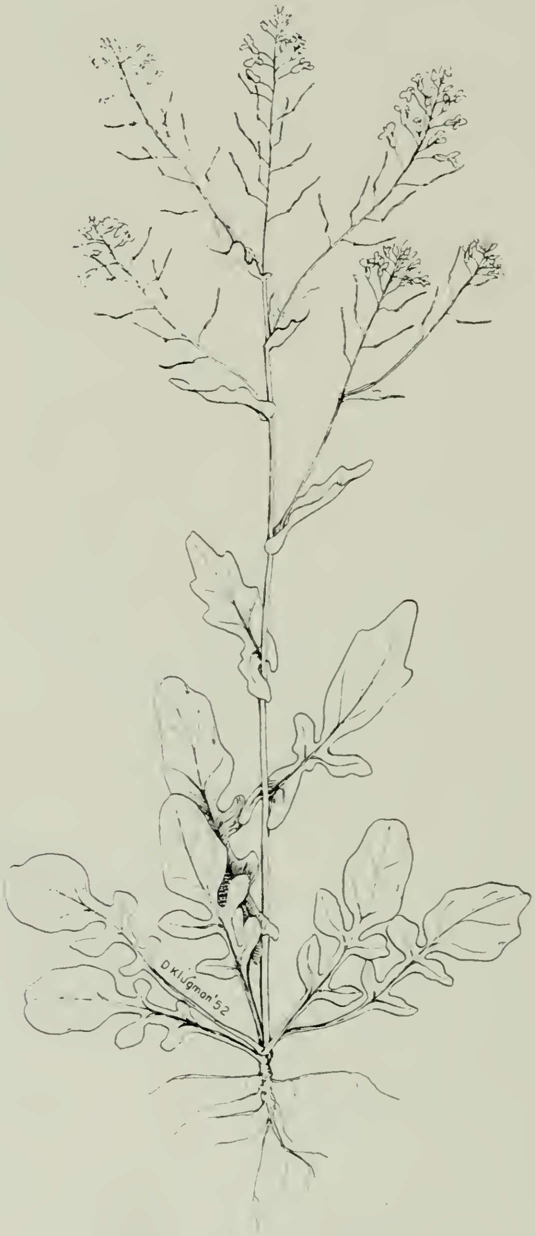


Fig. 28. Yellow rocket.

Yellow Rocket, Winter-cress, *Barbarea vulgaris* R. Br. (Fig. 28), may be a biennial or short-lived perennial. It is from 1 to 2 feet high with smooth, simple or branching stems giving a clustered appearance. The lower leaves have long leaf-stalks, a few pairs of small lateral lobes, and a large, terminal lobe. Toward the top of the stem, the leaf-stalks become shorter, and the leaves may eventually clasp the stem. The terminal lobes of the upper leaves are coarsely toothed. The leaves have a dark, glossy-green colour. The numerous flowers are small, bright yellow and quite showy. The seed-pods are somewhat four-angled, and are about 1 inch in length. Seed (Plate 20, no. 10).

At least 2 varieties are common: The seed-pods of the typical species are closely appressed to the stem; those of the other variety are spreading as shown in Fig. 28.

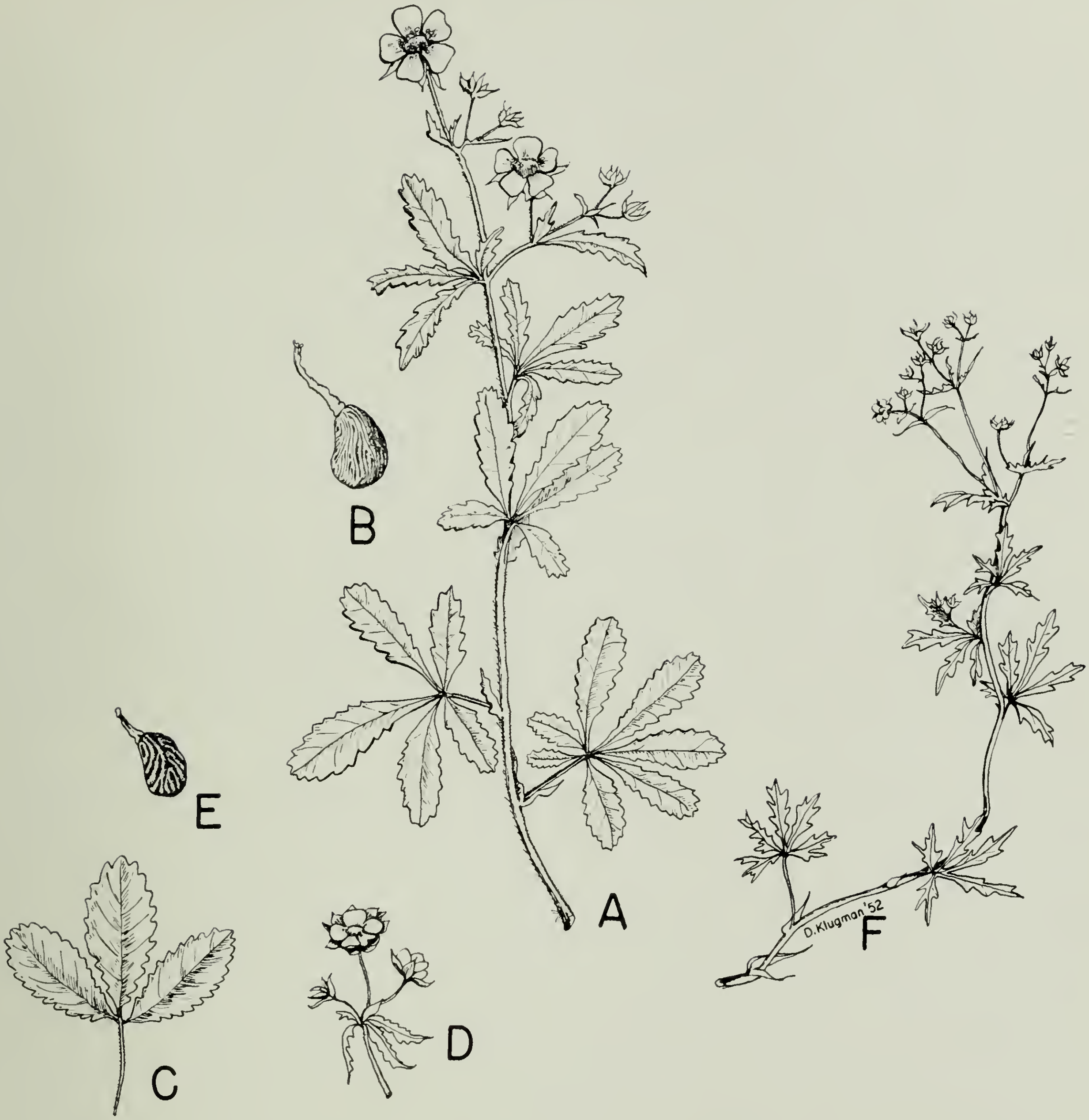


Fig. 29. A and B, Plant and fruit of rough-fruited cinquefoil. C, D, E, Leaf, flower and fruit of rough cinquefoil. F, Silvery cinquefoil.

Hawthorn, Thorn-apple, *Crataegus* species. The shrubs of hawthorn are becoming a common sight in cleared areas, pastures, and abandoned fields in southern Ontario. They have simple leaves often with sharply-toothed margins. They produce many white flowers in the late spring or early summer, and in the fall they may be loaded with usually reddish, small, apple-like fruit.

The shrubs often become infected with rusts which in turn may attack mountain ash, pear, quince and apple. Hawthorns also may serve as a source of bacteria which cause fireblight of apple and pear. In some instances the shrubs may harbour the apple-maggot. All *Crataegus* species in the vicinity of commercial pear or apple orchard should be removed.

Rough-fruited Cinquefoil, *Potentilla recta* L. (Fig. 29A), is a perennial weed usually in uncultivated land. The rather tough, branching, hairy stems may be 1 to 2 feet high. The long-stalked leaves are five to seven parted from one point, and are quite hairy. The flowers resemble in structure those of the strawberry or raspberry, but the petals are a pale, sulphur-yellow, and the fruit consists of a head of dry seed-pods. Fruit (seed) (Fig. 29B and Plate 20, no. 11).

Potentilla intermedia L., resembles very closely the rough-fruited cinquefoil. It is less robust and has smaller and darker yellow flowers. It has been observed most frequently in the eastern counties.

A somewhat similar species is the **Rough Cinquefoil,** *Potentilla norvegica* L. It is annual or biennial, and flowers later in the year than the rough-fruited cinquefoil. The leaves have only three leaflets (Fig. 29C). The yellow petals are smaller than those of the previous species, and scarcely as long as the green bracts (calyx) under them (Fig. 29D). Fruit (seed) is shown in Fig. 29E and Plate 20, no. 12.

Silvery Cinquefoil, *Potentilla argentea* L. (Fig. 29F), is often a reclining plant, and found most frequently in dry soils. The stems are densely covered with white hairs, and the leaflets (usually 5) are dark green above and white-woolly on the under surface. The edges of the leaflets are slightly rolled toward the lower surface. The small, yellow flowers are in leafy clusters at the ends of the branches.

The cinquefoils in or near strawberry patches are often hosts of the strawberry-weevil.

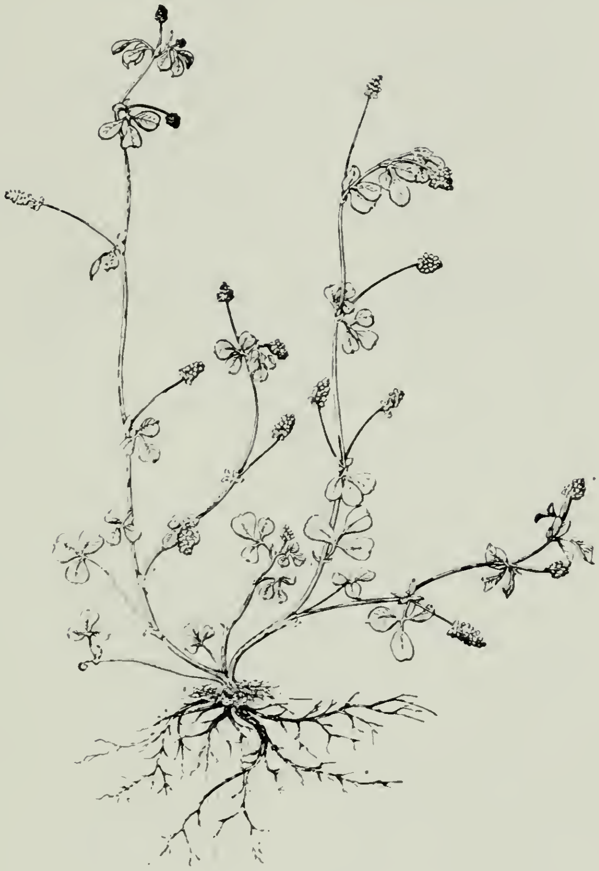


Fig. 30. Black medick.

Black Medick, Yellow trefoil, *Medicago lupulina* L. (Fig. 30), is a winter annual widely distributed in fields, gardens and lawns. The branching, hairy stems, unless supported by some means, trail along the ground. The leaves have three leaflets which are almost oval in shape or broadest at the tips. The margins of the leaflets are toothed near the tips, and there is a notch at the tip in which is a short spine. The yellow flowers are in small clusters, and are, in general, similar to those of the peas and beans. The seed-pods are black, slightly coiled, and have prominent ridges (Plate 20, no. 14).

Tufted Vetch, Bird vetch, Tare, *Vicia cracca* L. (Fig. 31), is one of the perennial vetches occurring in open fields and along roadsides. It can be identified quickly by the rootstocks which are not found in other common vetches. It has a weak, hairy, reclining stem, and the leaves have many leaflets. The terminal leaflet is modified to form a branching tendril by means of which the plant may attach itself to supporting objects. The flowers arise from the junction of the stems and the leaf-stalks, and the many, small, pea-like, purple flowers are on one side of the flowering stalk. The small pea-like pods are about one-quarter inch wide and contain 6 to 8 seeds.

Tufted vetch is often confused with **Hairy Vetch,** *Vicia villosa* Roth. The root of this latter species, however, is not perennial. The plant has more spreading hairs, and the flowers are fewer in number and larger than in the former species. The seed-pods are broader and longer than those of tufted vetch. It is

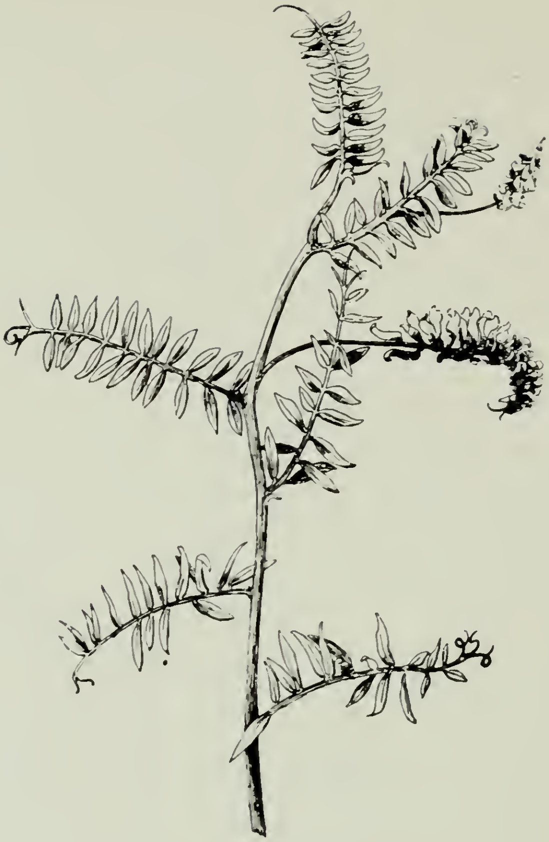


Fig. 31. Tufted vetch.

often introduced as a pasture and fodder plant, or for green-manure, and being an annual may reproduce each year by its seeds once it has been established in a field.

Narrow-leaved Vetch, Wild tare, *Vicia angustifolia* Reich., has the same general characteristics as tufted vetch. It is an annual or winter annual, almost hairless, has fewer leaflets, and these are longer and more tapering than those of tufted vetch. The purple flowers, without stalks (sessile), develop in pairs at the junction of the upper leaves and the stem. The ripe seed-pods are about 2 inches long, black and contain 10 to 16 seeds.

These members of the legume family are hosts of the pea-aphid, although some of the cultivated species, such as alfalfa, may be more important hosts.

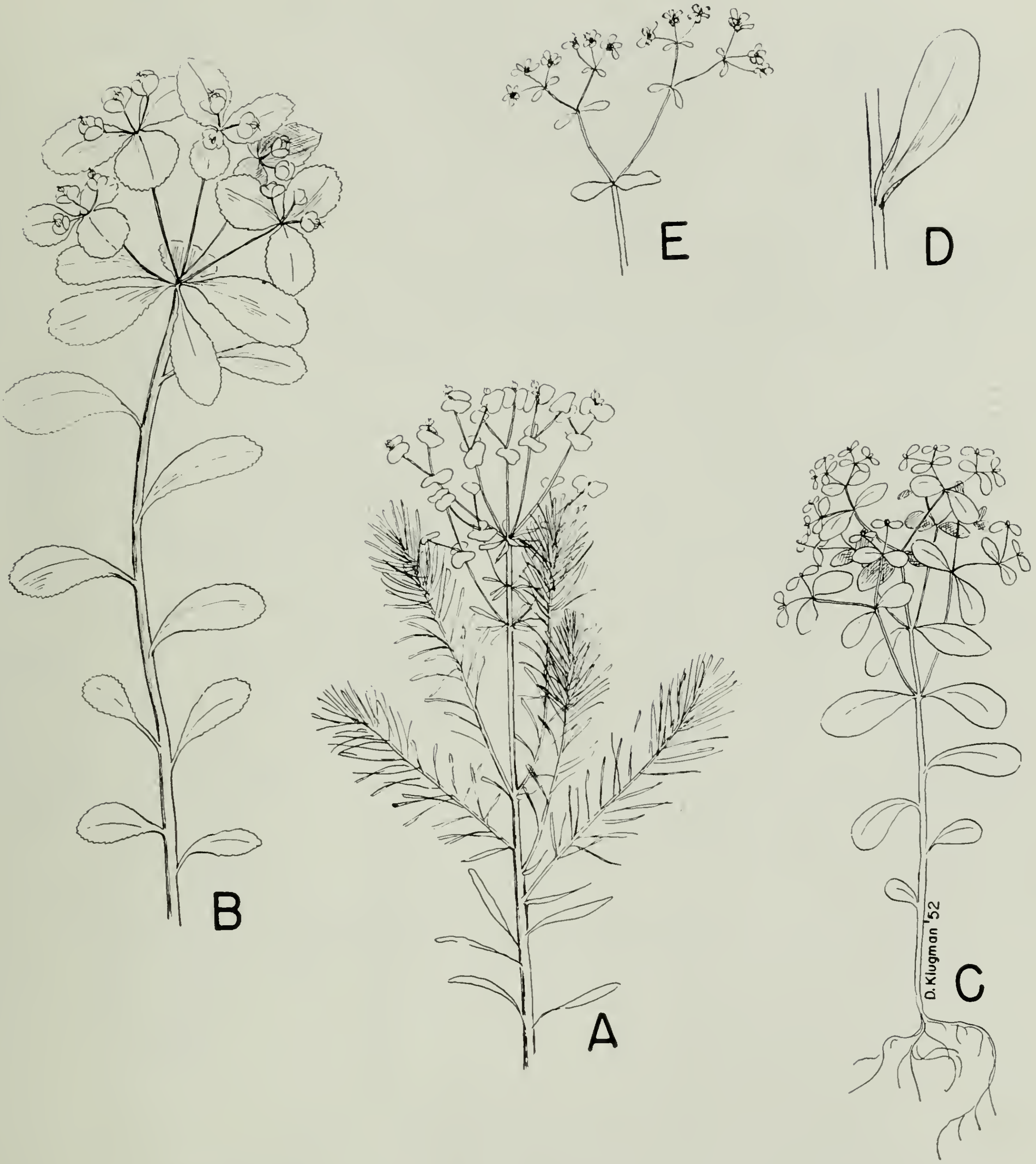


Fig. 32. A, Cypress spurge. B, Sun spurge. C, Petty spurge. D, and E, Leaf and flowers of flowering spurge.

Cypress Spurge, *Euphorbia cyparissias* L. (Fig. 32A). The above ground structure may originate from seeds or from the perennial rootstock. The plant has a bushy appearance because of the low branching stems and the many closely-crowded, smooth, narrow leaves. The flower-stalks occur in clusters (umbels) from one point at the top of the stem and branches, or from the axils of the leaves. At the base of the umbels is a small rosette of leaves. Each stalk of the umbel branches. Where it divides, and also under each flower-cluster, is a pair of roundish leaves.

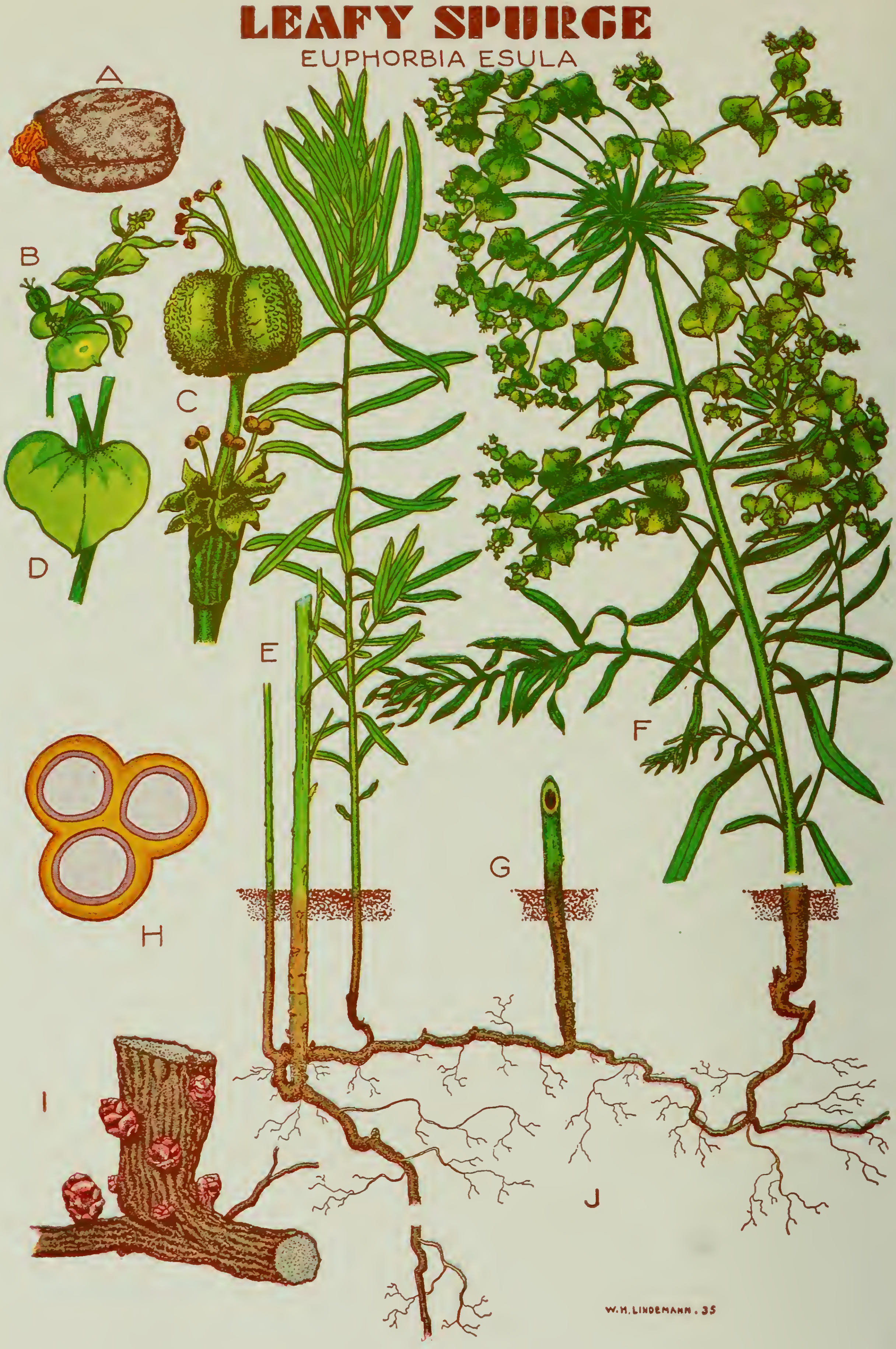


Plate 5. Leafy spurge.

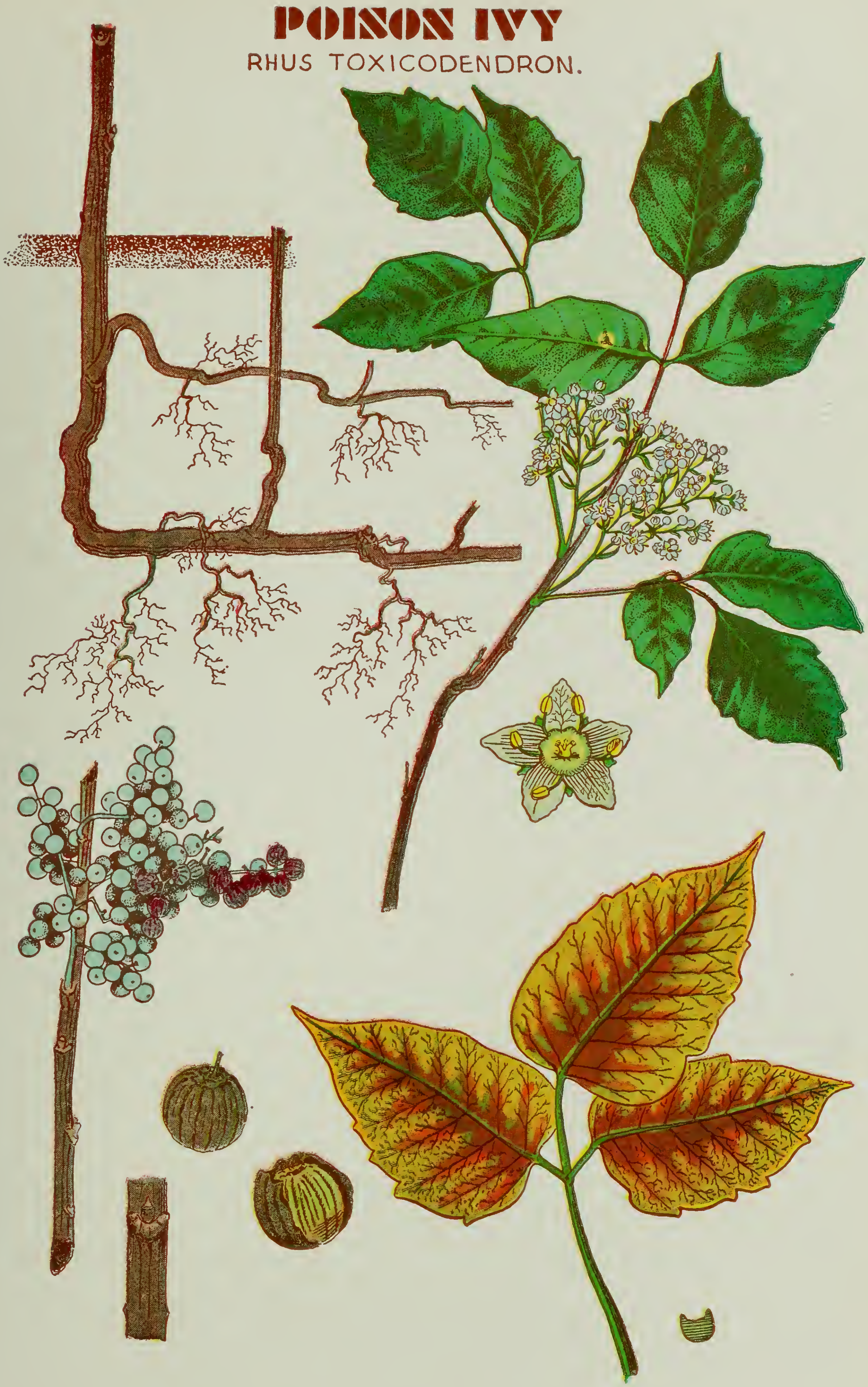


PLATE 6. Poison ivy.

Leafy Spurge, *Euphorbia esula* L. (Plate 5). It is a deep-rooted perennial and grows from 1 to 3 feet tall. It reproduces by seeds and rootstocks. The leaves are long and linear, and not so crowded as in the Cypress spurge. The bracts under the umbel are larger, and those under the flower may be lighter coloured than those of Cypress spurge. Both the leaves and the bracts may have a slightly whitened appearance (glaucous). Seed (Plate 20, no. 15).

Control — Circular 125, Ontario Department of Agriculture.

Sun Spurge, *Euphorbia helioscopia* L. (Fig. 32B), is an annual, and is easily distinguished from the preceding species by the broad-tipped leaves which taper to a short leaf-stalk, and the small teeth around the margin. The leaves at the base of the umbels and the flower cluster are even broader than the stem leaves. The umbels have only 3 to 5 divisions in comparison with the numerous divisions of the previous species.

Petty Spurge, *Euphorbia peplus* L. (Fig. 32C), is the smallest species of those described here, growing only 6 to 12 inches high. It is an annual, and has oval leaves tapering to thin leaf-stalks. The leaves of the umbels and flower clusters have short stalks or none. The flowers are small and inconspicuous.

Flowering Spurge, *Euphorbia corollata* L., is common in some areas, and persists by perennial rootstocks. The leaves are rather long and more or less elliptical in shape (Fig. 32D). The bracts of the flowering branches are much smaller than the stem-leaves, and the small, petal-like structures immediately around the flowers are white, giving the plant a distinctive appearance (Fig. 32E).

In southwestern Ontario, the **Broad-leaved Spurge**, *Euphorbia platyphylla* L., may be seen frequently. The stem-leaves have a heart-shaped indentation at the base, and are hairy on the under surface.

THE CASHEW FAMILY (*ANACARDIACEAE*)

Poison Ivy, *Rhus radicans* L. (Plate 6). A perennial, shrubby plant found in a variety of habitats. It spreads by seeds and by shoots from the creeping rootstocks. The stem may be short, or it may climb over fences and trees. The leaves are alternate on the stems, and have three leaflets which are variable in appearance, but most frequently have wavy or toothed margins. The plants may be hairy or almost smooth. The flowers are in clusters on long stalks from the junction of the leaf-stalks and the stems. They are greenish coloured and produce a whitish or yellowish fruit.

All parts of the plant are apparently poisonous to many people, causing irritating inflammation and blisters on the skin. Many remedies have been suggested for poison ivy infection, and probably the cures vary with the individual. If infection has occurred, it is best to get advice from a physician.

If one has come in contact with poison ivy, a recommended first aid treatment is a thorough washing with a strong soap solution of the parts of the body that have come in contact with the plant.

Poison ivy can be distinguished very easily from Virginia creeper. It has only three leaflets whereas Virginia creeper has five.

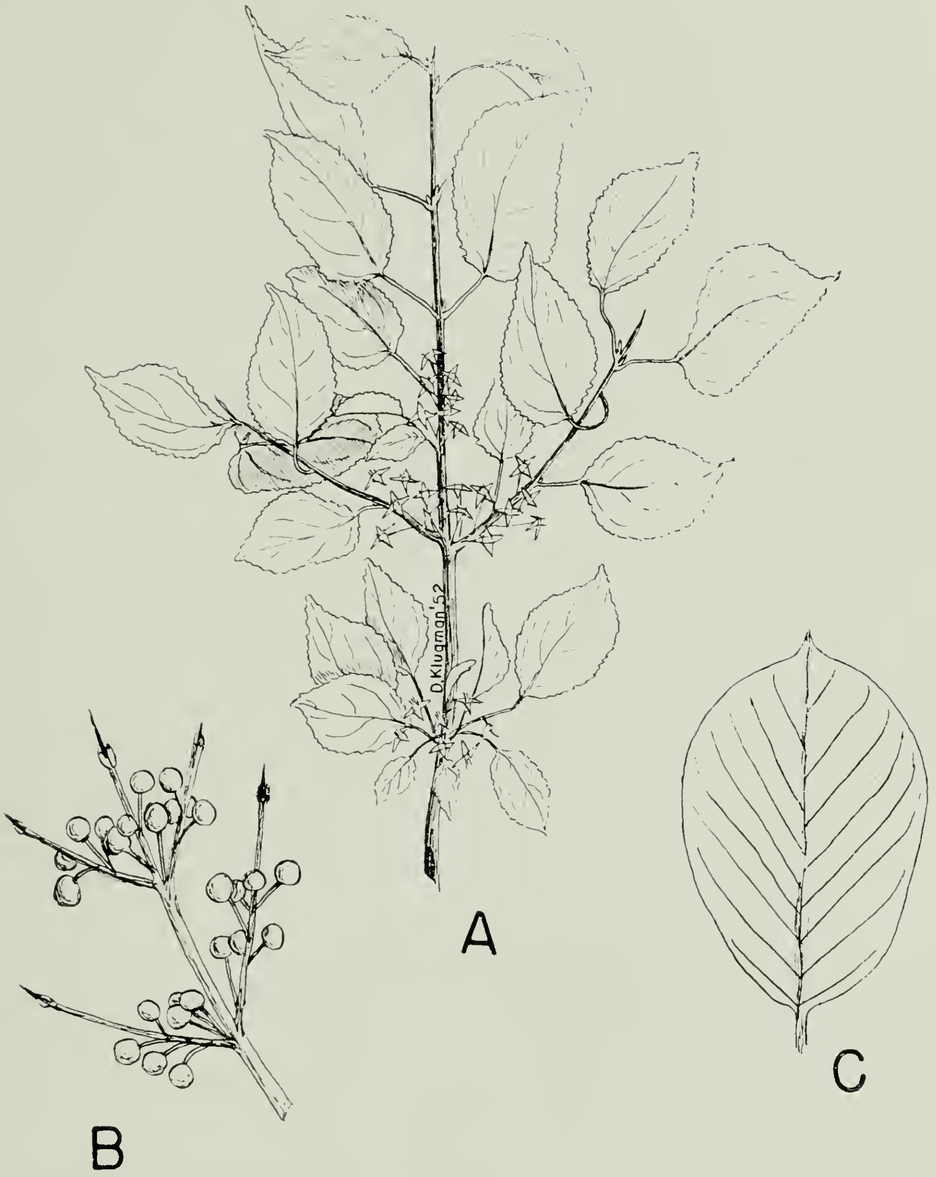


FIG. 33. A, Branch of common buckthorn. B, Fruiting branch. C, Leaf of alder buckthorn.

Common Buckthorn, *Rhamnus cathartica* L. (Fig. 33A), is a shrub varying considerably in size. It is very bushy, and the shoots terminate with a sharp spine. The leaves are opposite, elliptical in outline, smooth, and with toothed margins. The main veins do not extend to the edge of the leaf, but curve upwards towards the tip. The flower clusters are at the junction of the twigs and the leaves, and the flowers are small and greenish. The fruit (Fig. 33B), when fully mature, is bluish to nearly black and very bitter to the taste.

The barberry is a host plant for one of the stages of the stem-rust of grain. In a similar manner, the common buckthorn is a host plant for the leaf-rust of oats. In the spring the cluster cup stage of this disease develops on the under side of the buckthorn leaves. From these cluster cups the disease spreads to the oats. See Extension Circular No. 49, Ontario Department of Agriculture.

A second introduced species, the **Alder Buckthorn,** *R. frangula* L., is common in some areas, particularly in swampy ground. The leaves are elliptical or slightly broader above the middle of the blade (Fig. 33C). The margins are without teeth, and the blades have heavy parallel veins. It lacks the thorns at the ends of the twigs. The fruit is black and bitter.

THE MALLOWS (*MALVACEAE*)

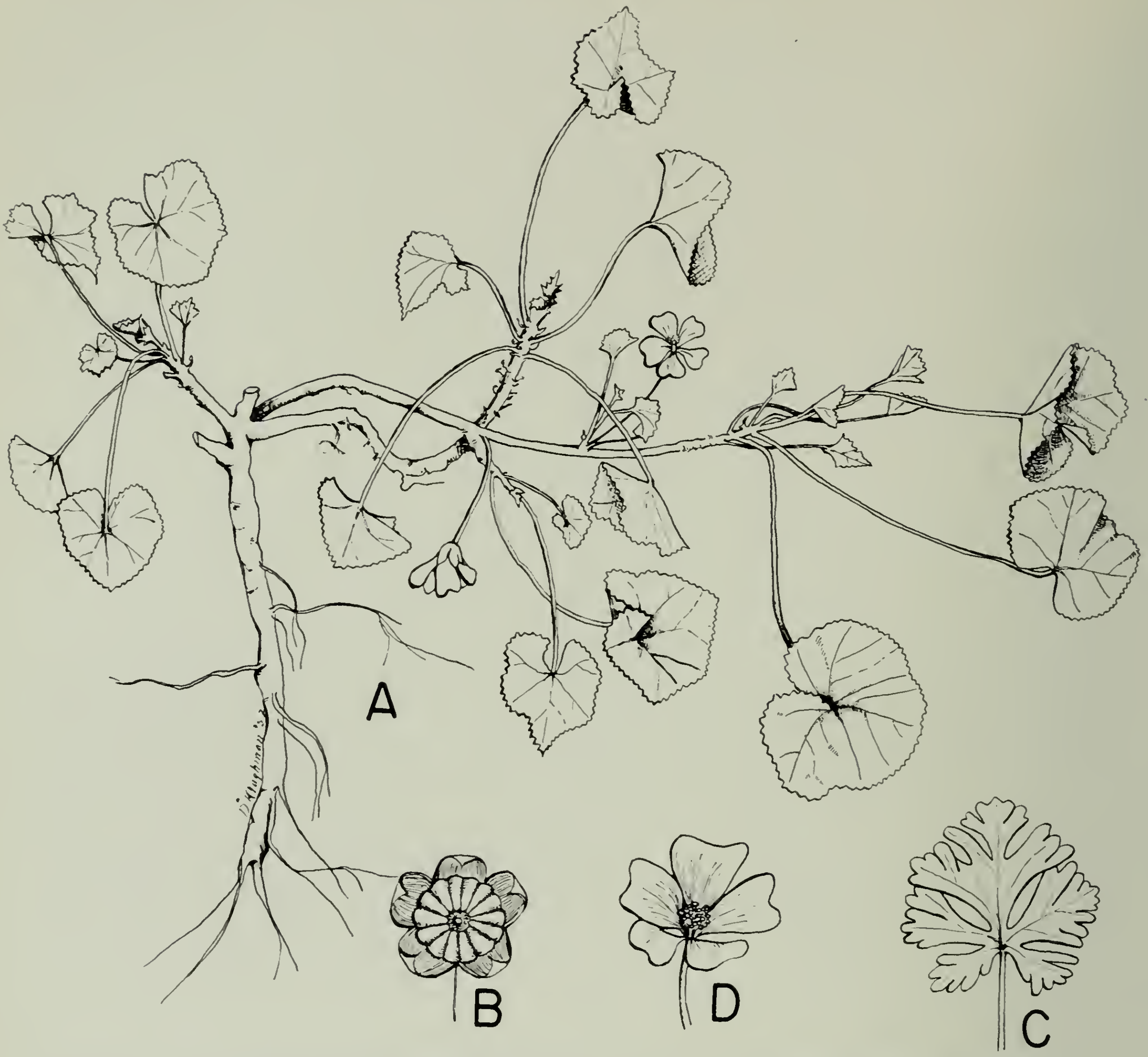


FIG. 34. A, Round-leaved mallow. B, Fruit. C, Leaf of musk mallow. D, Flower.

Round-leaved Mallow, Cheeses, *Malva neglecta* Wallr. (Fig. 34A). This is an annual or biennial weed found in many different habitats. The stems trail along the ground, and have alternate, long-stalked, hairy, rounded leaves with heart-shaped bases. The small hollyhock-like flowers originate where the leaves join the stems, and are white or slightly pinkish. The fruit, like that of the hollyhock, consists of a ring of small triangular sections (Fig. 34B). Fruit (seed) (Plate 20, no. 16).

Malva rotundifolia L. is similar to the above species, but the flowers are much smaller; the petals are about as long as the sepals, and the base of the petals have hairs on them. It has not the wide distribution of *Malva neglecta.*

Musk Mallow, *Malva moschata* L., is a perennial, erect plant found often in formerly cultivated fields and along roadsides. It has deeply divided leaves with each division also deeply cut (Fig. 34C). The flowers are much larger than in the previous species, being about 2 inches in diameter. They may be white or pink (Fig. 34D). The fruit is also similar to that of hollyhock. This plant is frequently grown in gardens as an ornamental.

Flower-of-an-Hour, *Hibiscus trionum* L. (Fig. 35). In some sections of southwestern Ontario this is becoming a troublesome weed in home gardens and in market gardens. It is a low, branching, hairy annual. The alternate leaves have long leaf-stalks, and the leaf-blades are three-parted. Each leaf-segment is coarsely toothed or lobed. There are a number of hairy bracts below the flower, and the hairy calyx is distinctly marked with dark lines. The petals are light yellow with a purple area at the base of each petal. The fruit is surrounded by the calyx which at maturity becomes swollen or bladder-like.

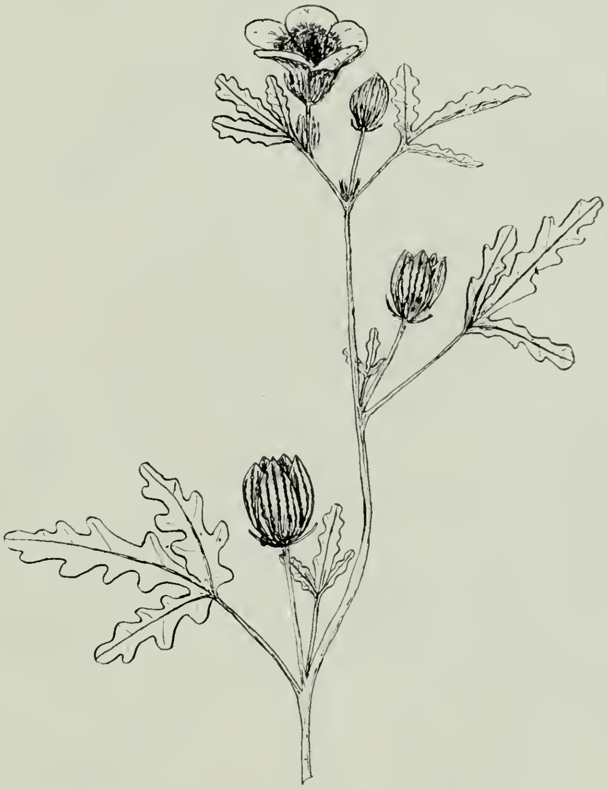


Fig. 35. Flower-of-an-hour.

COMMON ST. JOHN'S-WORT

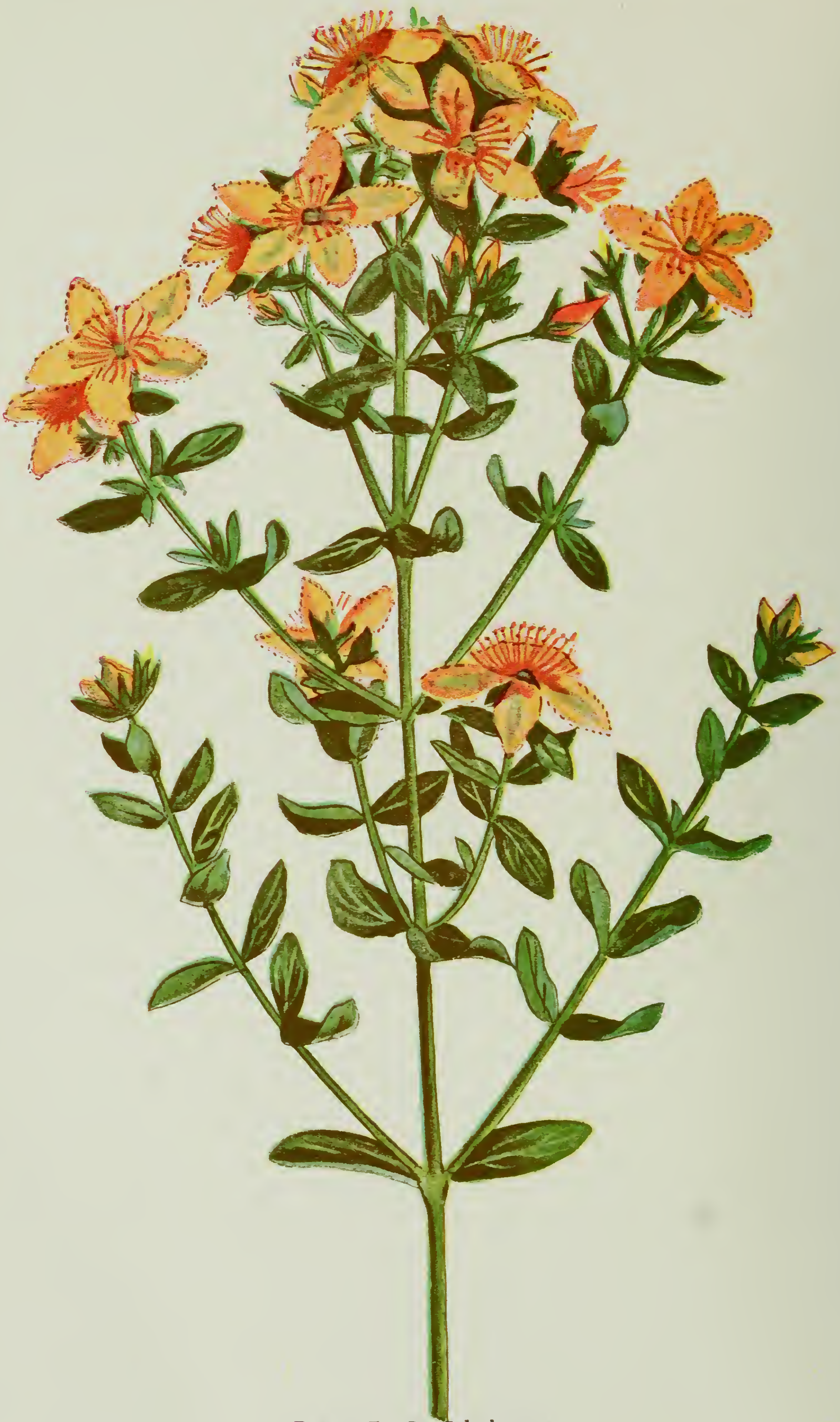


Plate 7. St. John's-wort.

Velvet-Leaf, *Abutilon theophrasti* Medic. (Fig. 36), is also becoming a frequent weed in southwestern Ontario. It is a stout, much branched annual, 3 to 4 feet in height, and the whole plant has a velvety feeling. The leaves are large, heart-shaped, sharply pointed at the tip, and slightly toothed on the margins. The yellow flowers originate in the axils of the leaves, and are about an inch in diameter. The fruiting-head consists of numerous divisions which form a ring of seed-pods.

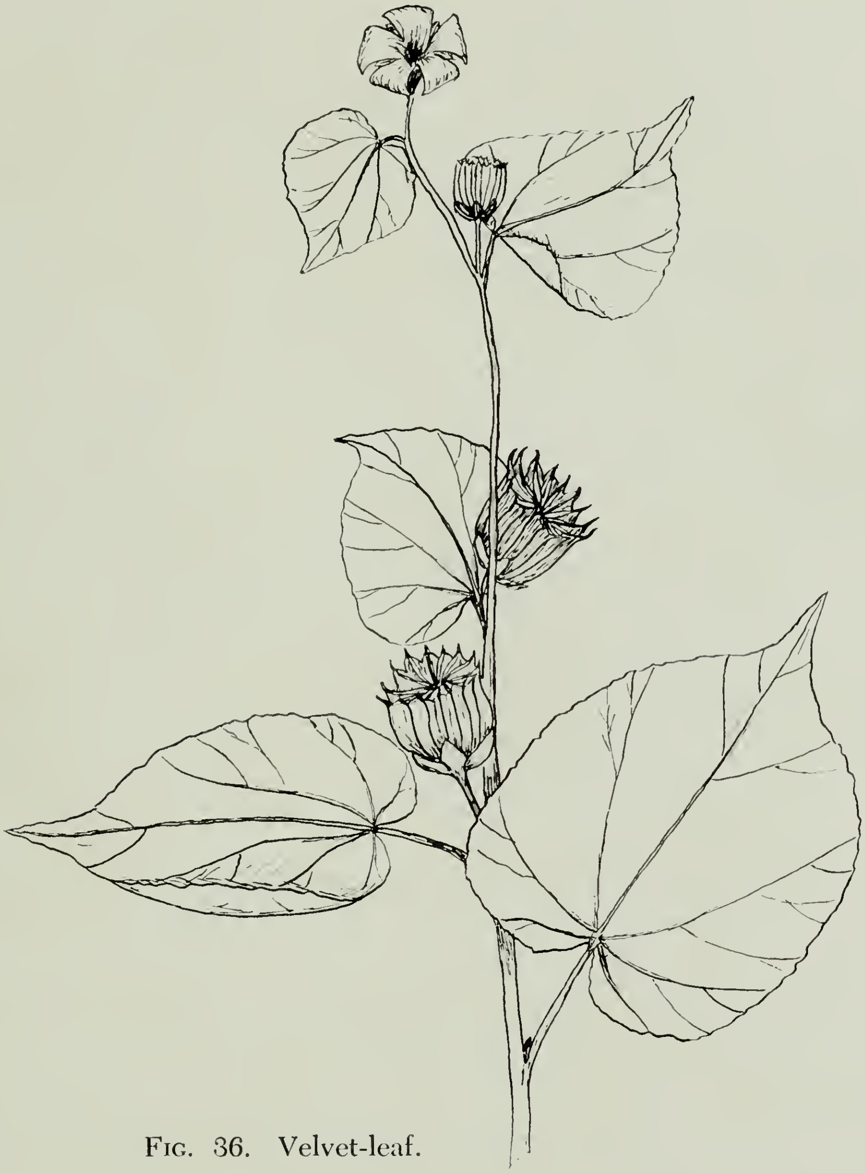


Fig. 36. Velvet-leaf.

THE ST. JOHN'S - WORT FAMILY (*GUTTIFERAE*)

St. John's - Wort, *Hypericum perforatum* L. (Plate 7). This perennial weed reproduces by seeds and rootstocks. It has a very branching, smooth stem, and a bushy top. The opposite, smooth-margined leaves are elliptical in shape, with leaf-stalks, and if one holds a leaf toward the light, it appears to have numerous holes, giving a perforated appearance. The flowers are quite numerous and bright yellow with black dots around the edges of the petals. It has a large number of stamens in 3 to 5 clusters. Seed (Plate 20, no. 17).

If this plant is eaten in quantity by animals, it produces an irritation of the skin surface when the animals are exposed to bright sunlight. This occurs most frequently on hairless or unpigmented portions of the body. For details see bulletin on poisonous plants.

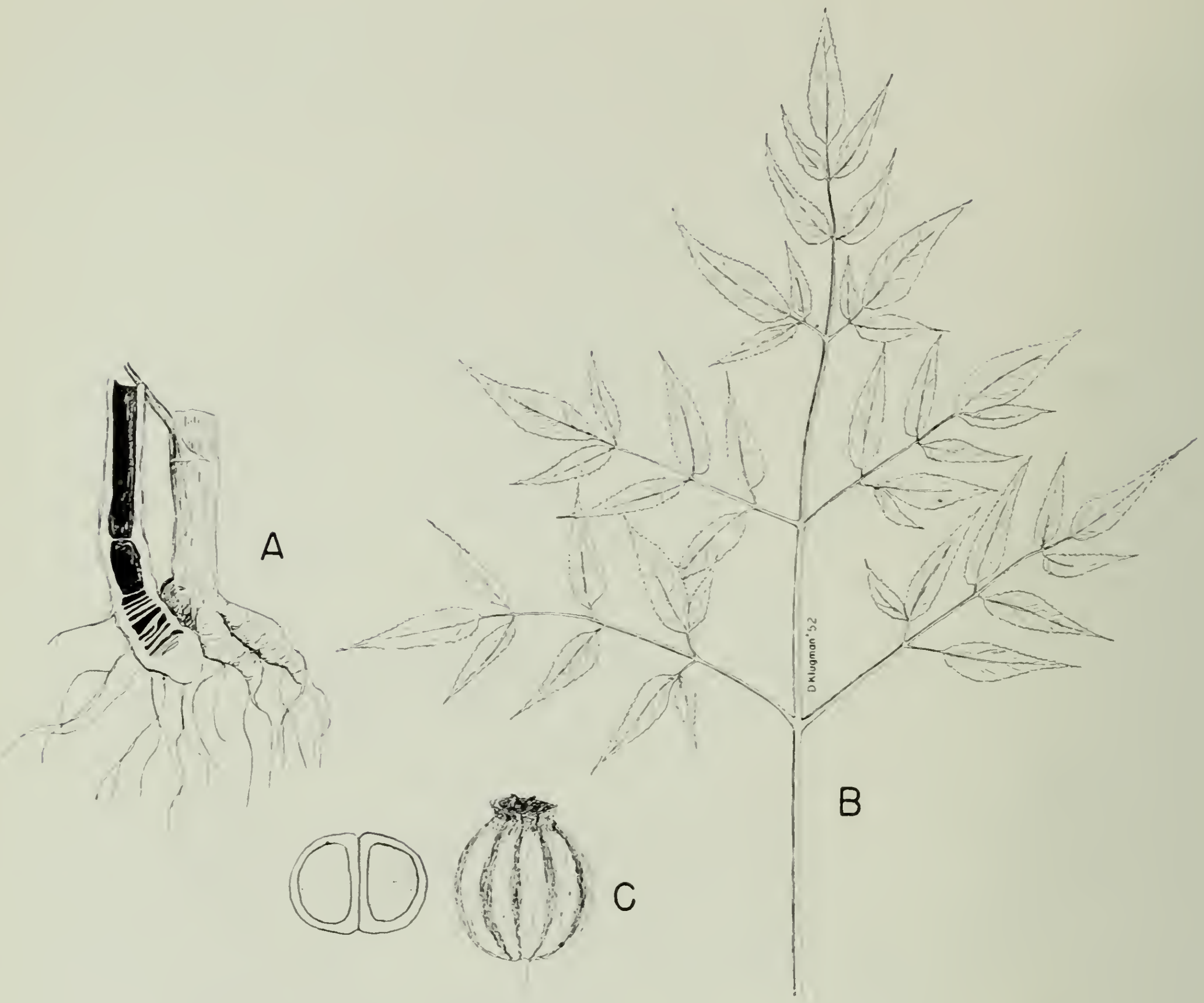


FIG. 37. Water hemlock. A, Base of stem and root. B, Leaf. C, Fruit.

Water Hemlock, Spotted Cowbane, *Cicuta maculata* L. (Fig. 37), is found in wet soils. It is perennial, 2 to 6 feet high. It reproduces by seeds and by the somewhat dahlia-like tuberous roots. The cross-partitions in the pith at the base of the stem of a well developed plant are characteristic (Fig. 37A). The stems are hollow, smooth, sometimes purple-striped and ridged. The alternate leaves have the characteristic broad base to the leaf-stalks where they join the stems. The leaves are three-parted, each division is again divided, and the leaflets have sharp-toothed margins. Usually one of the basal leaflets has a smaller leaflet attached to it (Fig. 37B). The white flowers are in large clusters (umbels) each divided into secondary umbels. The fruit is an important feature to observe when identifying the plant (Fig. 37C and Plate 21, no. 2).

This plant is poisonous to livestock, and low pastures should be carefully examined for its presence, or livestock prevented from feeding in pastures in which it is present. The tuberous roots are the most poisonous part of the plant.

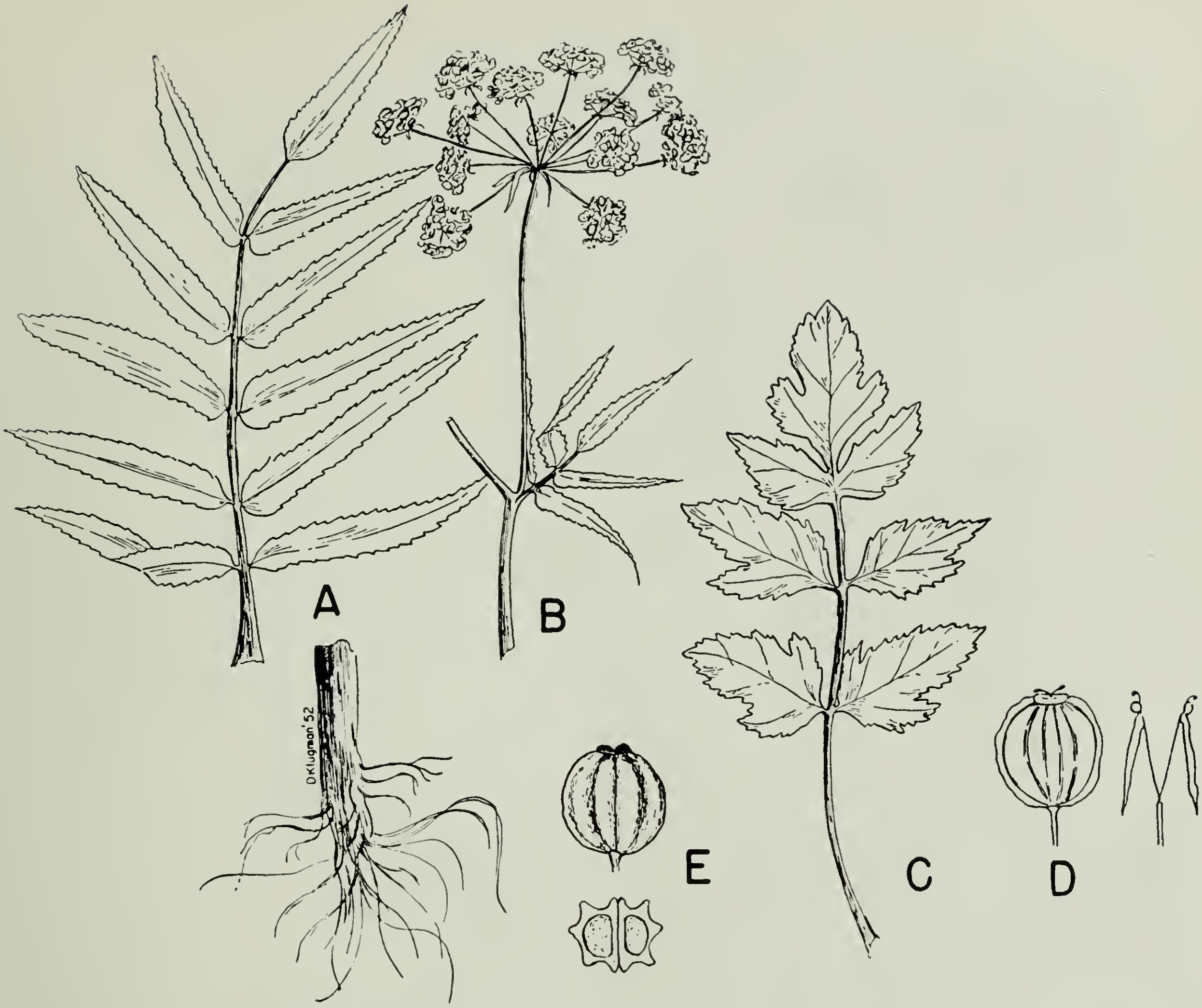


FIG. 38. A and B, Leaf root and flowers of water parsnip. E, Fruit. C, Leaf of wild parsnip. D, Fruit.

Water Parsnip, *Sium suave* Walt. (Fig. 38A & B), is an inhabitant of low wet ground. It is a perennial with smooth, ridged, branching stems. The leaves have 3 to 8 pairs of toothed leaflets (Fig. 38A). The flowers (Fig. 38B) are similar to the former species, but the fruit has prominent ridges on the rounded surface, (Fig. 38E). It is often mistaken for water hemlock. Its reported poisonous properties are without confirmation.

Wild Parsnip, *Pastinaca sativa* L., is found in damp soils. This is the wild form of the cultivated parsnip, and resembles it in general appearance. A leaf is shown in Fig. 38C. The flowers are in umbels, and are bright yellow. The fruits resemble those of the parsnip (Fig. 38D and Plate 21, no. 4).

This plant is known to be a host of the carrot rust-fly.

Wild Carrot, Queen Anne's lace, *Daucus carota* L. (Plate 8), is a biennial weed, and is a very common sight in pastures, abandoned fields and along roadsides. The carrot-like odour, fine, lacy leaves and umbels of white flowers are characteristic. After flowering the tightly folded "bird's nest" of developing fruit is a feature. The fruit has rather heavy ridges with many hooked spines (Plate 21, no. 5).

Wild carrot is an important host of the carrot rust-fly, which attacks carrots, and to a lesser extent parsnips, celery, and parsley. It may also harbour the tarnished plant-bug.

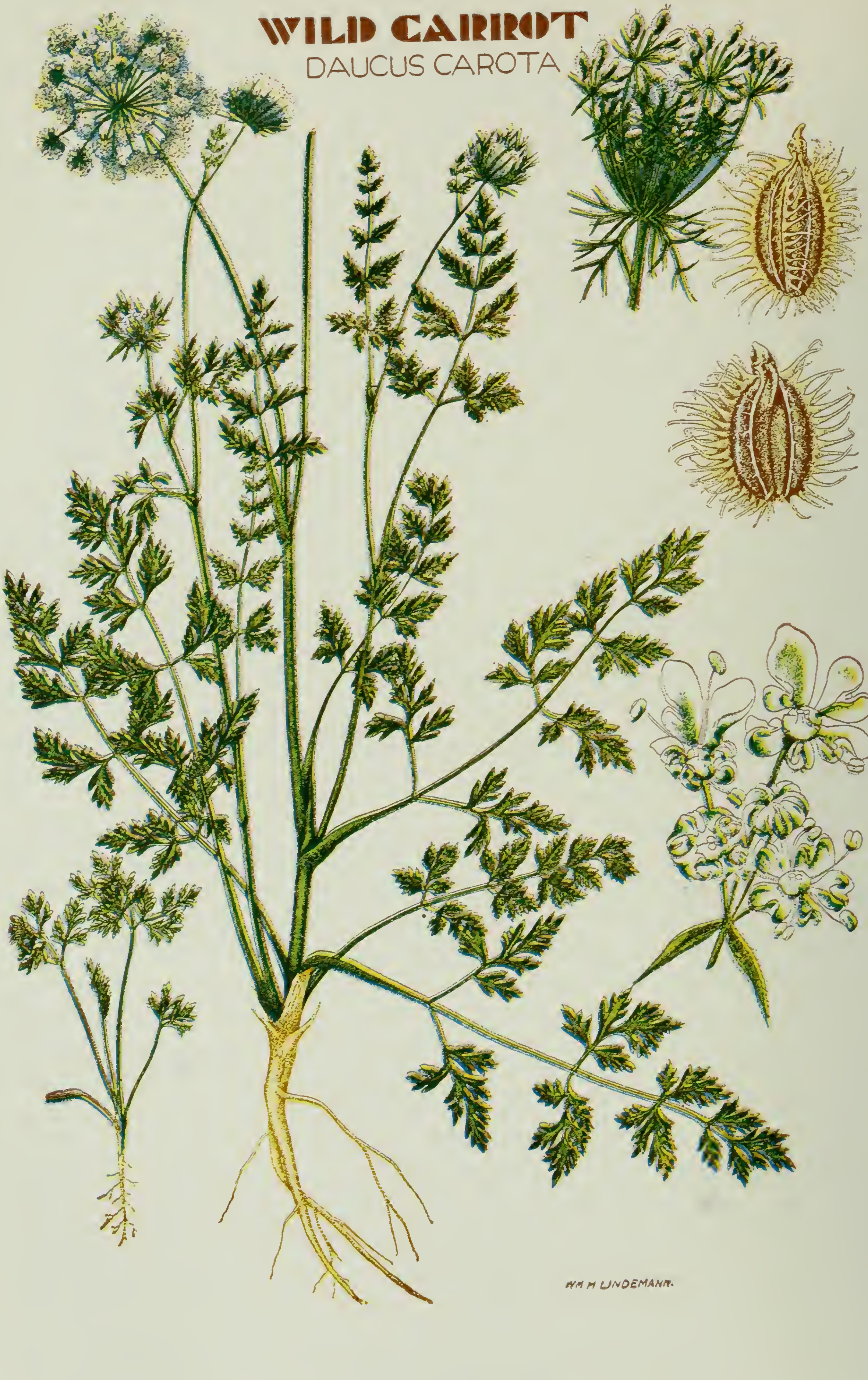


Plate 8. Wild carrot.

THE MILKWEED FAMILY (*ASCLEPIADACEAE*)

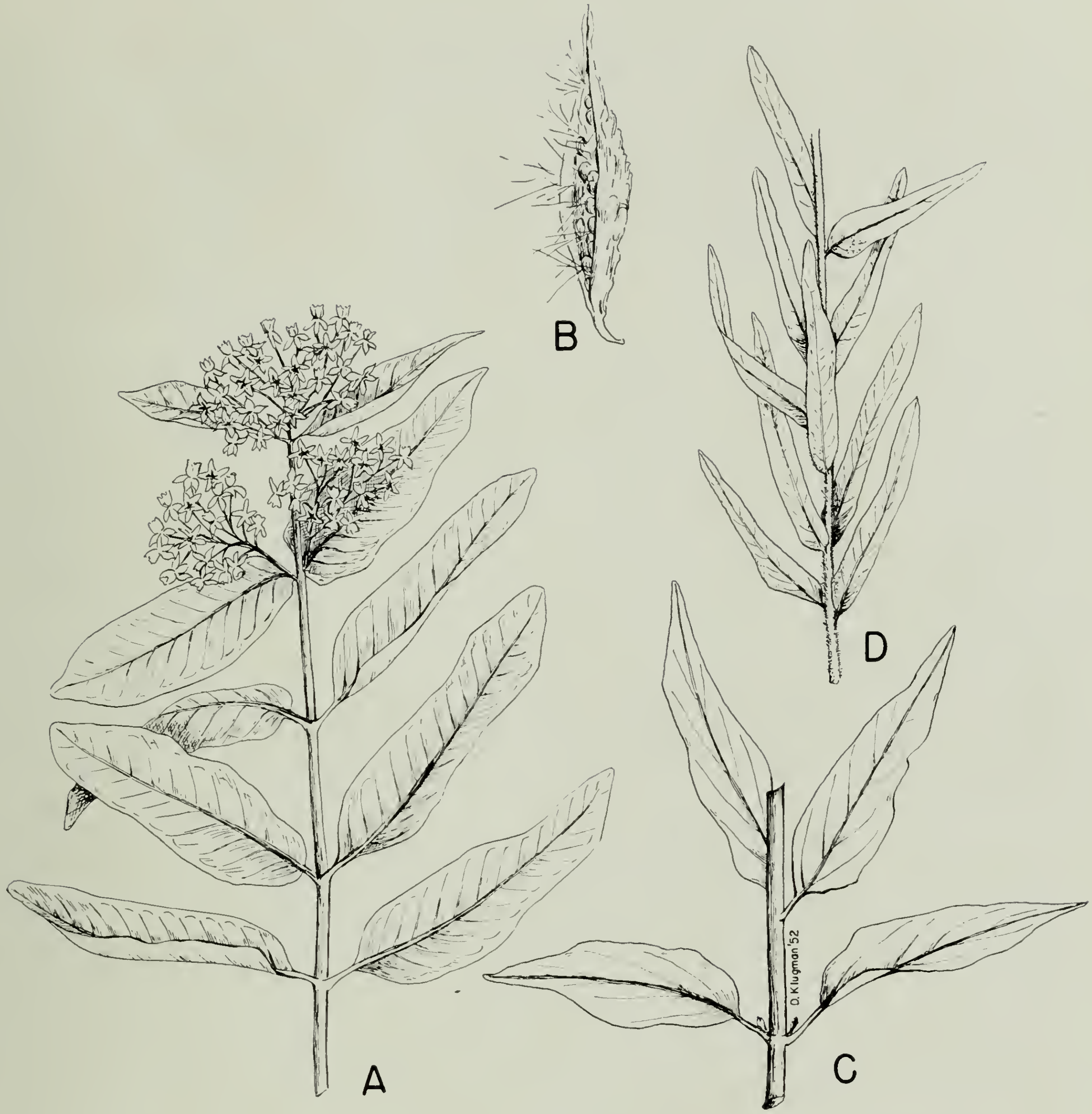


Fig. 39. A, Common milkweed. B, Seed-pod. C, Part of stem of swamp-milkweed. D, Part of stem of butterfly-weed.

Common Milkweed, *Asclepias syriaca* L. (Fig. 39A), is a perennial, reproducing by seed and shoots from the rootstocks. The stems are 2 to 5 feet high, unbranched, finely hairy, and have a milky juice. The leaves are opposite, short-stalked, much-veined and smooth-margined. They are green and smooth on the upper surface, but light coloured and velvety-hairy on the lower surface. The flowers are in umbels, creamy or purplish in colour. The two outer flower parts bend downward when the flowers open. One or two pods may develop from a flower. The pods (Fig. 39B) are warty, and split down one side when ripe, exposing the numerous brown seeds which have tufts of hairs on their upper ends to aid in their dispersal. Seed (Plate 21, no. 6).

In swampy places the **Swamp Milkweed**, *Asclepias incarnata* L. is found. It is quite smooth with stalked, narrow leaves tapering to a point (Fig. 39C). The flowers are in umbels, and deep pink to reddish in colour. The pods are long, elliptical, pointed and smooth.

Butterfly-weed, Orange milkweed, *Asclepias tuberosa* L., is common in some parts of Ontario, particularly in sandy areas. It is easily identified by its bright, orange-coloured flowers, and tough, rough, hairy stems without milky juice. The leaves are narrow, hairy (Fig. 39D), without stalks, and the seed pods are long and slender.

THE MORNING-GLORY FAMILY (*CONVOLVULACEAE*)

Field Bindweed, *Convolvulus arvensis* L. (Plate 9). This is a perennial, reproducing by seeds and the underground stems. The above ground stems are weak and twine themselves around any object with which they come in contact. The leaves are very variable in appearance, and the plate shows one common form. The flowers are white or slightly pink and funnel-shaped like those of the morning-glory. The fruit contains 4 seeds. Seed (Plate 21, no. 7).

Hedge Bindweed, *Convolvulus sepium* L., has characteristics similar to the above, but the leaves and flowers are much larger. The flowers have two large green bracts under them, which are not found in the field bindweed. Seed (Plate 21, no. 8).

Dodder, *Cuscuta* species (Plate 10, see p. 53). Dodder is an annual, reproducing by seeds. These seeds, on germinating, produce a light-coloured, thin, vine-like stem which winds itself around a host plant with which it comes in contact. This stem then produces numerous "roots," haustoria, which penetrate the host plant and absorb nourishment for the dodder. This robs the host plant of food which it requires, and thus prevents development. As the dodder plant does not have any green material it cannot manufacture food. The mature twining stems of dodder are yellowish or orange in colour, and without leaves. They produce clusters of small whitish flowers. The seed-pods contain 2 to 4 seeds. Seed (Plate 21, no. 9).

A large number of weeds may be hosts for dodder, and in crop producing areas where infestations occur, every effort should be made to eradicate both the dodder and its hosts.

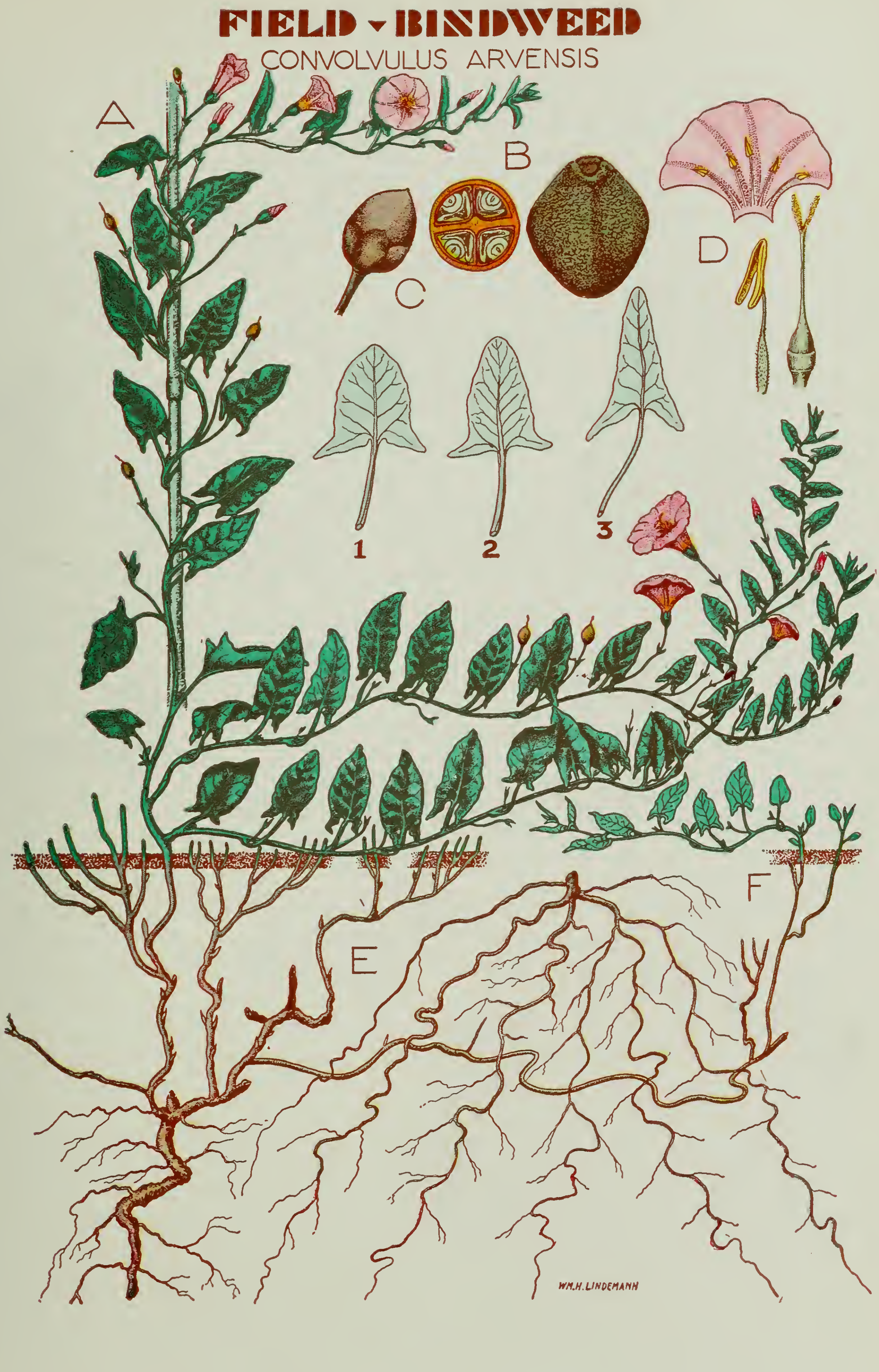


Plate 9. Field bindweed.

THE BORAGE FAMILY (*BORAGINACEAE*)

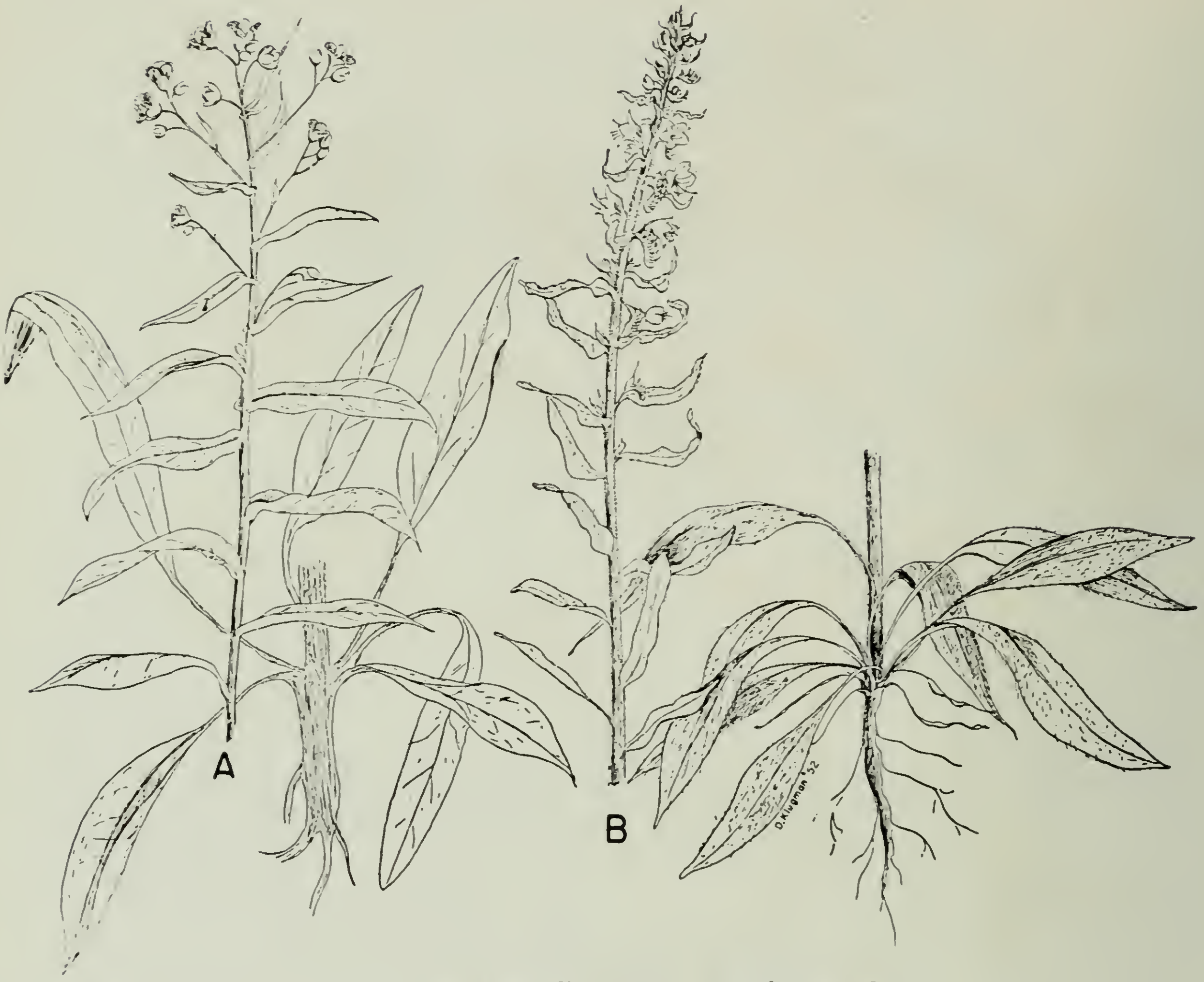


Fig. 40. A, Hound's tongue. B, Blue-weed.

Hound's Tongue, *Cynoglossum officinale* L. (Fig. 40A), is a biennial, reproducing by seeds. It has a long taproot, and the leaves of the basal rosette are soft and hairy, oblong or elliptical, with long leaf-stalks. The upper leaves may be without leaf-stalks. The flowers are maroon in colour and about one-half inch in diameter. The "seeds" are roughened by numerous, short, barbed prickles, by means of which they may attach themselves to animals coming in contact with them. Fruit (Plate 21, no. 12).

Blue-Weed, *Echium vulgare* L. (Fig. 40B), is biennial with a deep taproot. It develops from seed, and is usually restricted to well-drained, rather dry ground. In the fall, one may see the rosettes of dark green, rough, hairy leaves lying close to the ground. During the spring and summer the simple or branching stem develops. It is roughened by many bristles arising from coloured glandular spots on the stem. The stem-leaves are not stalked, and are oblong in shape and rather soft-hairy. The plant produces numerous, irregular blue or purplish flowers, and the long stamens and styles project from the flower. The fruit consists of 4 irregularly-shaped nutlets (Plate 21, no. 10).

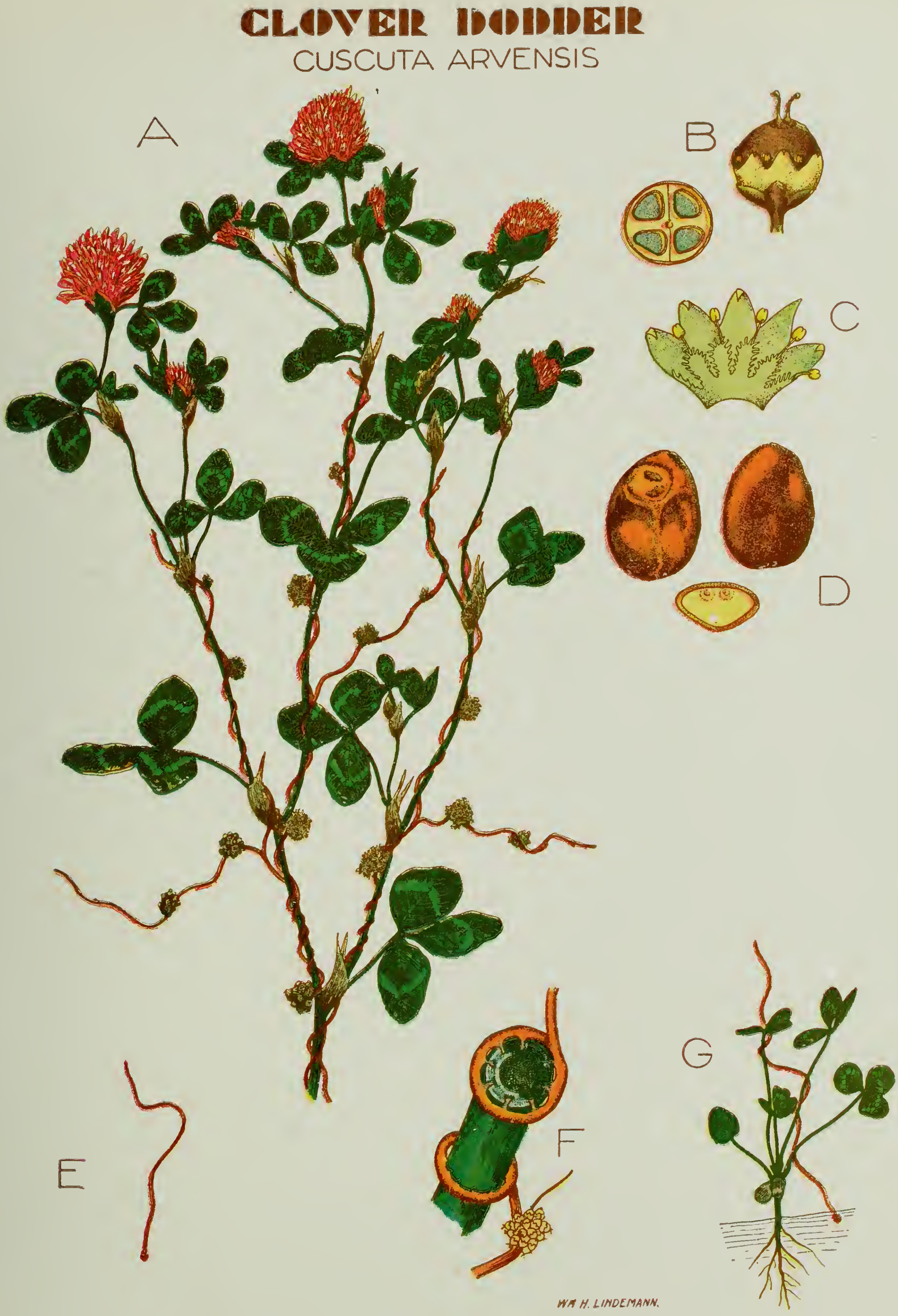


PLATE 10. Dodder.

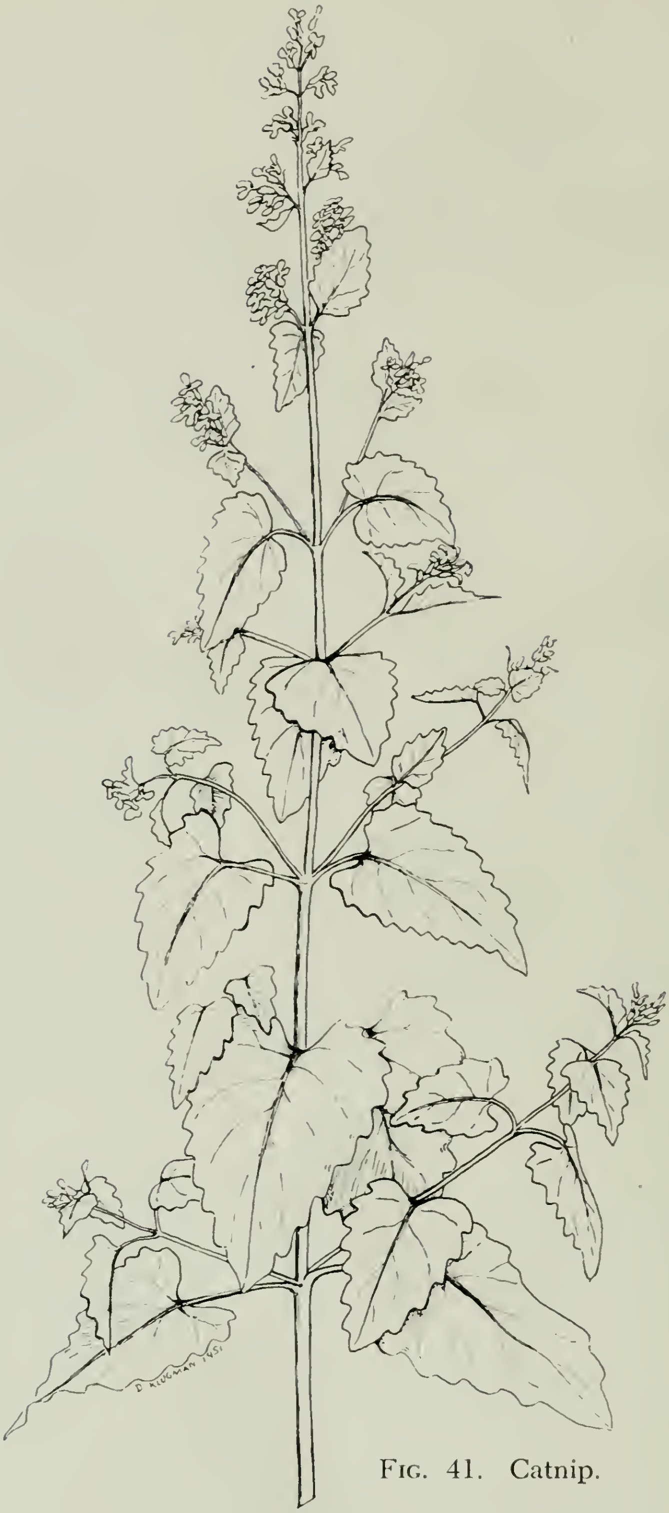


FIG. 41. Catnip.

Catnip, *Nepeta cataria* L. (Fig. 41), is not usually a weed of cultivated fields. It is a perennial reproducing by seeds and by shoots from the rootstocks. The stems may become 2 to 4 feet high, and are simple or branching. The plant has the typical square stem of the mint family, and has numerous, short, soft hairs. The leaves are opposite, have thin stalks, rather triangular blades with coarsely-toothed margins and heart-shaped bases. The light, purple-spotted flowers are in dense clusters along the upper ends of the stems and branches. The fruit consists of 4 nutlets, and the seed is dark coloured and has 2 distinctive white marks at one end (Plate 22, no. 2).

Creeping Charlie, Ground ivy, *Glecoma hederacea* L. (Fig. 42), is a perennial weed in a number of habitats, but very troublesome in lawns. It reproduces by seed, and by rooting at the joints of the creeping stems. The leaves are rounded and more or less kidney-shaped. The margins of the leaves have numerous rounded teeth. The flowers originate in the axils of the leaves and are purplish.

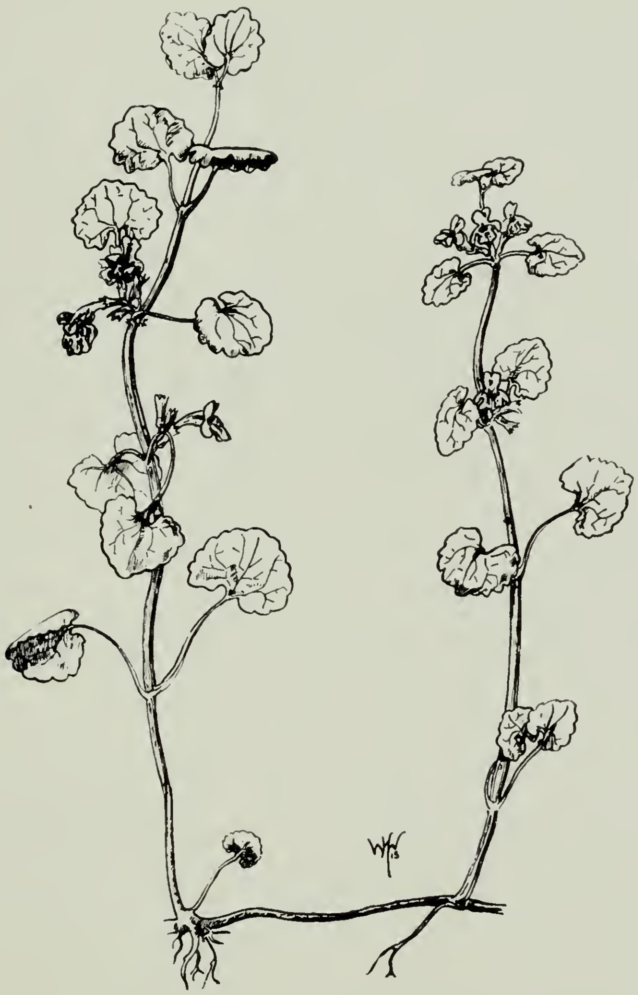


Fig. 42. Creeping Charlie.

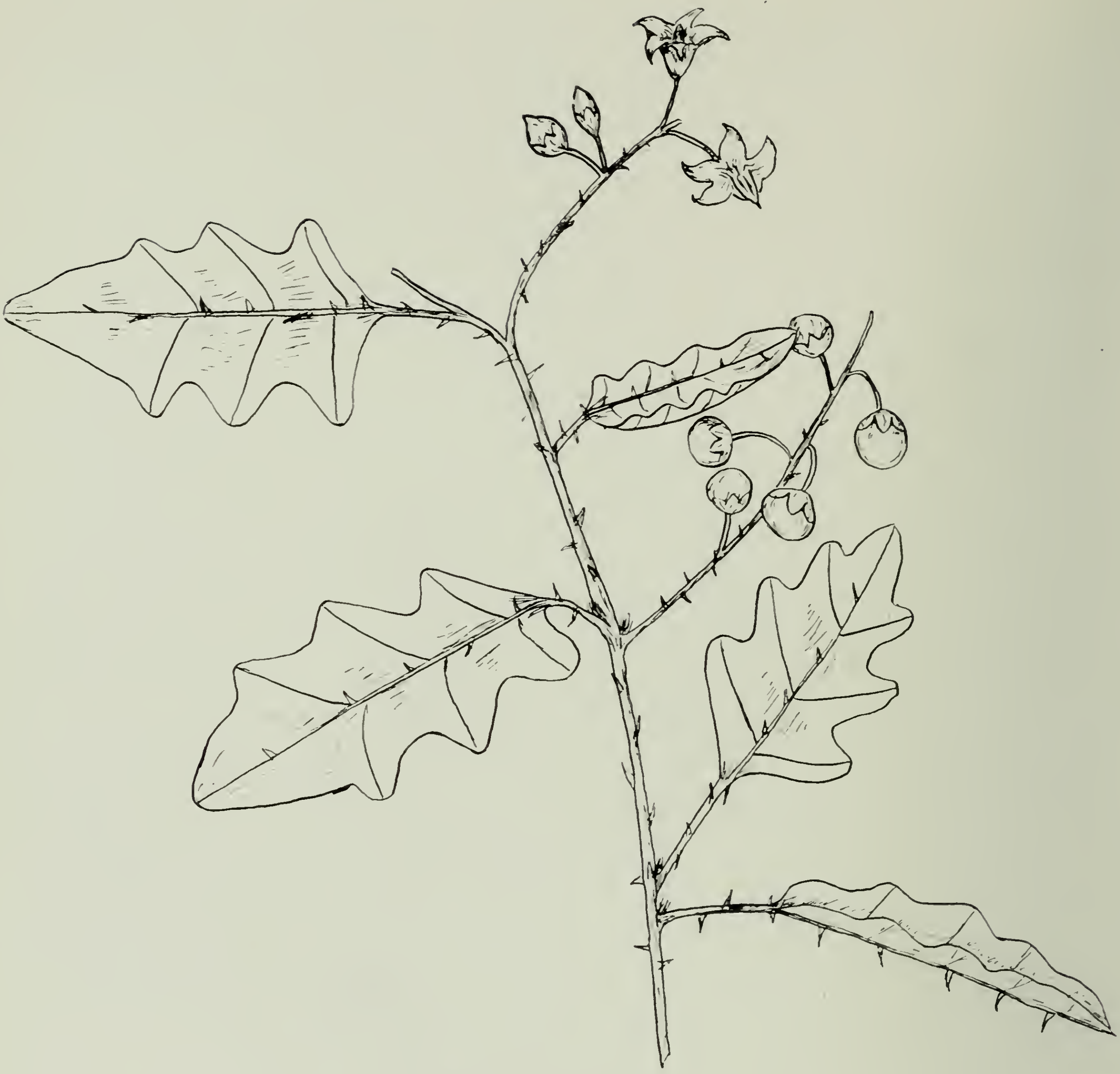


Fig. 43. Horse nettle.

Horse Nettle, *Solanum carolinense* L. (Fig. 43), is a perennial plant reproducing by seeds and by creeping rootstocks. The simple or branching stems and the veins of the leaves, particularly on the undersurface, have numerous stout, yellowish spines, and the whole plant is covered with short, star-shaped hairs. The rather large leaves have the margins deeply indented. The clusters of pale violet to white flowers resemble those of a potato. The yellowish fruit consists of a smooth berry similar to a small tomato.

THE FIGWORT FAMILY (*SCROPHULARIACEAE*)

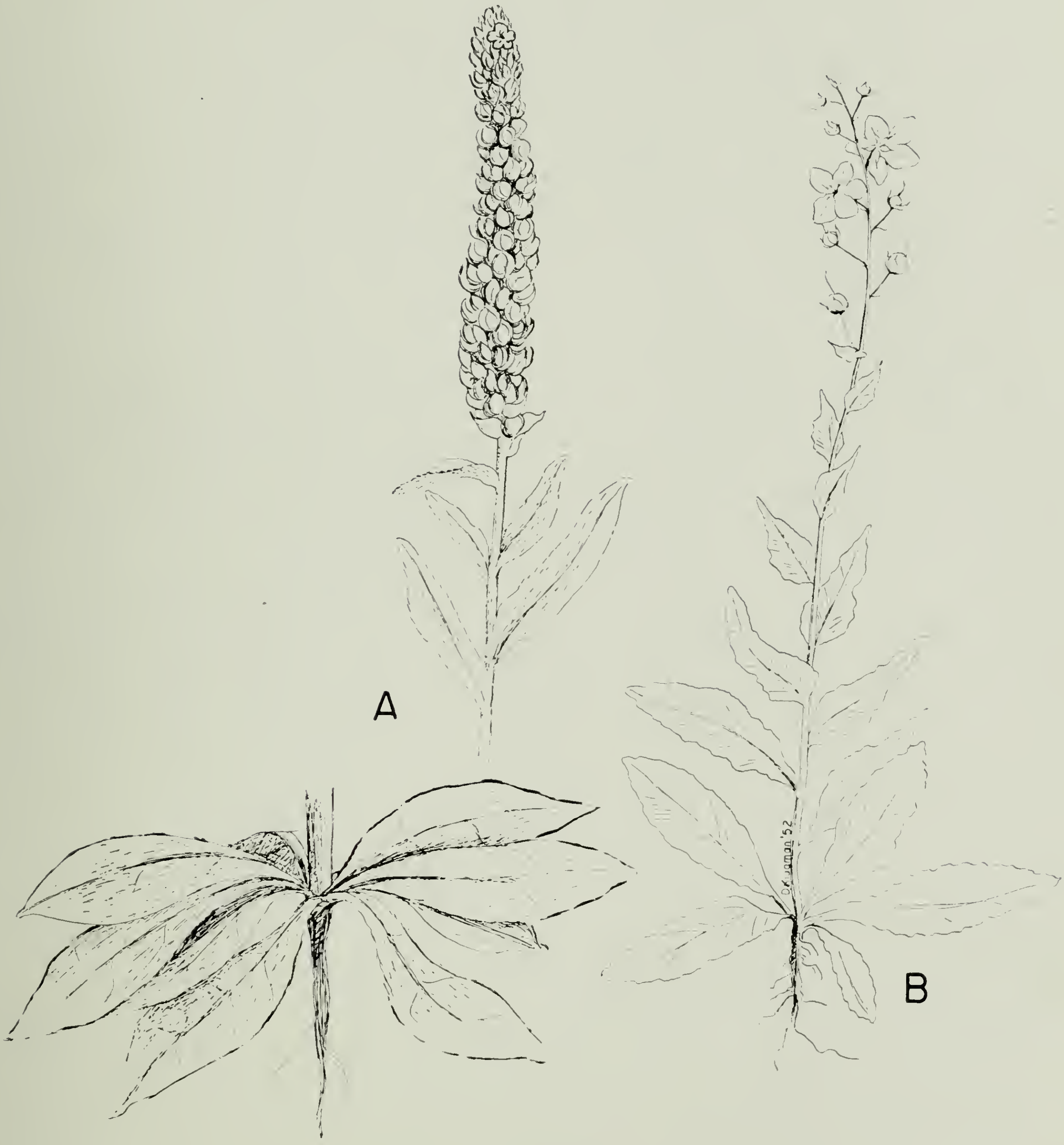


FIG. 44. A, Common mullein. B, Moth mullein.

Common Mullein, *Verbascum thapsus* L. (Fig. 44A). In the fall and spring the leafy rosettes of this biennial weed may be found in dry, usually sandy or gravelly ground. The leaves are large, very woolly, elliptical, tapering to a thick leaf-stalk. During the summer, the tall stem develops and the bases of its leaves extend down the stem to the next leaf, thus making the stem appear winged. The unstalked flowers are in a dense, elongated spike at the top of the stems. The flowers are woolly, and have small sulphur-yellow petals. Seed (Plate 22, no. 5).

The tarnished plant-bug is commonly found on the mullein.

Moth Mullein, *Verbascum blattaria* L. (Fig. 44B). This biennial is not as common as the previous species, but may be found frequently in some localities. It is not as large a plant as the common mullein, and has slender, simple or branching, smooth stems. The rosette leaves are large and deeply lobed, and the stem-leaves are toothed, and without leaf-stalks. The flowers occur singly along the stem, and are yellowish or pinkish-white. The seeds are enclosed in a smooth pod, with a distinct long point at the top. Seed (Plate 22, no. 6).

Toadflax, Butter-and-eggs, *Linaria vulgaris* L. (Plate 11), is a perennial, reproducing from seeds and underground stems. The stems are smooth, simple or branching. The leaves are alternate, narrow, without stalks, and pale green in colour or slightly whitened from the abundant "bloom." The flowers are along the upper part of the stem and look somewhat like the snapdragon flower. They are light yellow with an orange spot on the lower lip and a spur at the base of the lower petal. Seed (Plate 22, no. 7).

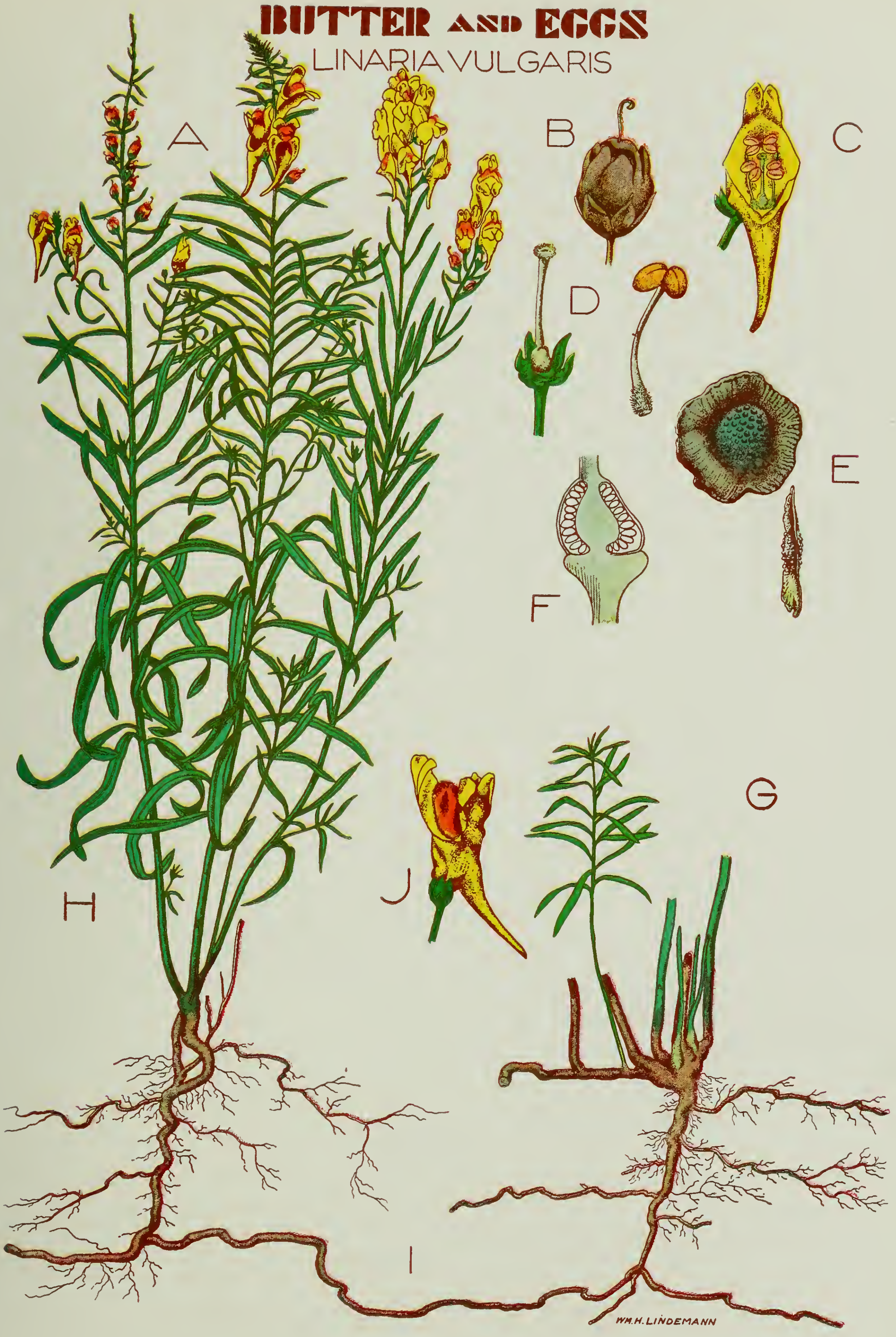


PLATE 11. Toadflax.

THE PLANTAIN FAMILY (*PLANTAGINACEAE*)

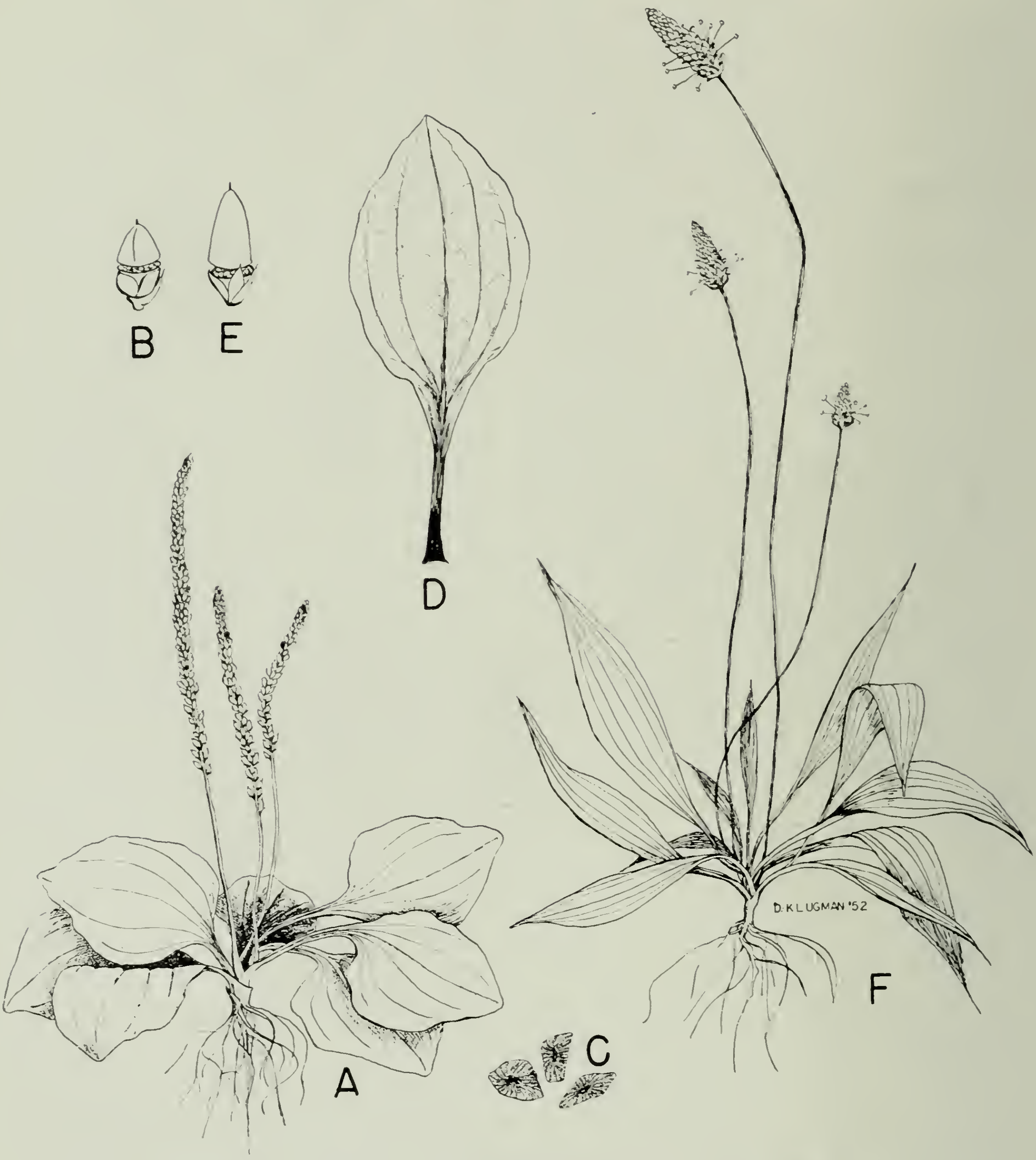


FIG. 45. A, Broad-leaved plantain. B, Seed-pod. C, Seed. D, Leaf of Rugel's plantain. E, Seed-pod. F, Ribgrass.

Broad-leaved Plantain, *Plantago major* L. (Fig. 45A), is a perennial, multiplying by seeds and shoots from the root-crown. The leaves lie close to the ground, and have long, broad leaf-stalks; smooth or hairy, rather oval blades; prominent veins running the full length of the blades, and smooth or wavy margins. The numerous small flowers are closely packed along the upper end of the flowering stem. The seed-pods are more or less egg-shaped, and the lid breaks off near the middle of the pod (Fig. 45B). Seed (Plate 22, no. 8).

Rugel's Plantain, Purple-stemmed plantain, *Plantago rugelii* Dcne., looks much like the previous species, but the leaves are more elliptical in shape, and the blades taper more to the leaf-stalk. The base of the leaf-stalk also has a purplish tinge where it joins the stem or crown (Fig. 45D). The seed-pods are longer, and the lid breaks off below the middle of the pod (Fig. 45E). Seed (Plate 22, no. 9).

Ribgrass, Buckhorn, Narrow-leaved plantain, *Plantago lanceolata* L. (Fig. 45F), is easily distinguished from our other common species by the long, tapering leaves which are more erect than in the other species described. The flowering stem is long and slender, and the spike of flowers is very short. Seed (Plate 22, no. 10).

The narrow-leaved plantain is a secondary host of the rosy apple-aphid, an important pest on some varieties of apples.

THE MADDER FAMILY (*RUBIACEAE*)

Bedstraws, *Galium* species. Several species of bedstraws are common. They are usually weak-stemmed, and spread over the ground or over adjacent plants, as in the yellow bedstraw, *Galium verum* L. The stems of bedstraws are 4-angled, and have whorls of rather small leaves. The flowers are small, usually white in weedy species, and produce large numbers of seeds.

One of the weedy species in Ontario is the White Hedge Bedstraw, *Galium mollugo* L. It is a perennial, frequently found in fields and along roadsides.

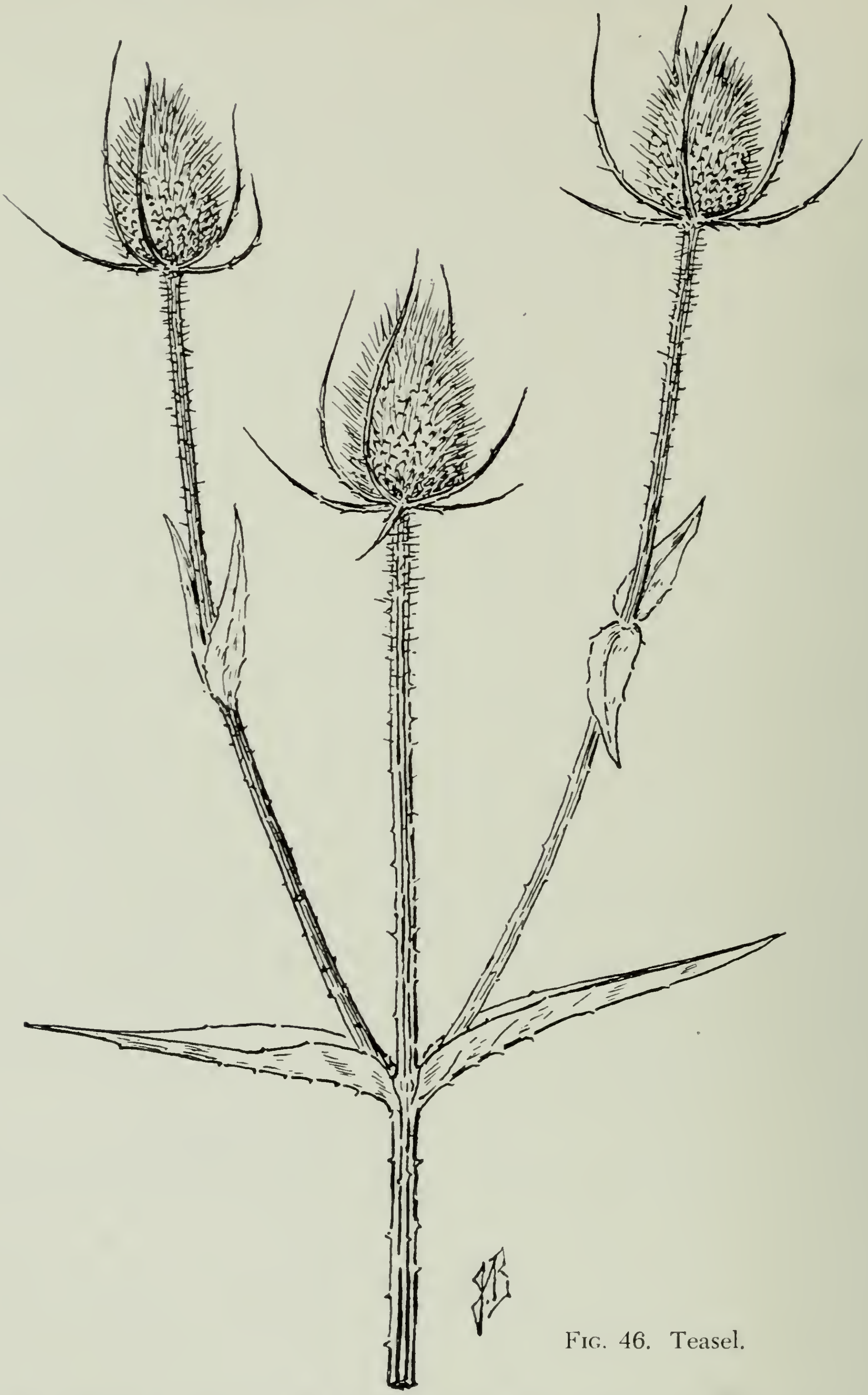


Fig. 46. Teasel.

Teasel, *Dipsacus sylvestris* Huds. (Fig. 46). This is a biennial, 5 to 6 ft. high. The first season's rosette of rather prickly leaves may be seen spreading over the surface of the ground in the fall. In the following spring and summer, the tall, prickly stems develop, and these have a few opposite leaves which are often united by their bases where they join the stem. The stems may branch at the top, and each branch terminates in a spiny cone of flowers at the base of which are stiff, prickly bracts. The numerous flowers in the head are small and purplish. Seeds (Plate 22, no. 11).

COMPOSITE FAMILY (*COMPOSITAE*)

Goldenrods, *Solidago* spp., are so well known that a description is unnecessary. They are perennial, but do not usually persist in cultivated ground. Goldenrods are common along fences, roadsides and in pastures. There are many species, some restricted to particular habitats.

Asters, *Aster* spp., are in the same category as the goldenrods, and are seldom of any importance as weeds in cultivated ground. Like the goldenrods, they may become an undesirable inhabitant of fences, roadsides and pastures.

The goldenrods and asters are favourite resorts of the tarnished plant-bug which may infest dahlias, chrysanthemums, celery, beets and strawberries.

Canada Fleabane, Horseweed, *Erigeron canadensis* L. (Fig. 47A). This is a simple-stemmed annual, reproducing by seeds, and varying in height from a few inches to 6 feet or more. The lower leaves are long, hairy, with slightly toothed margins, and broader at the tips than at the bases. The upper leaves

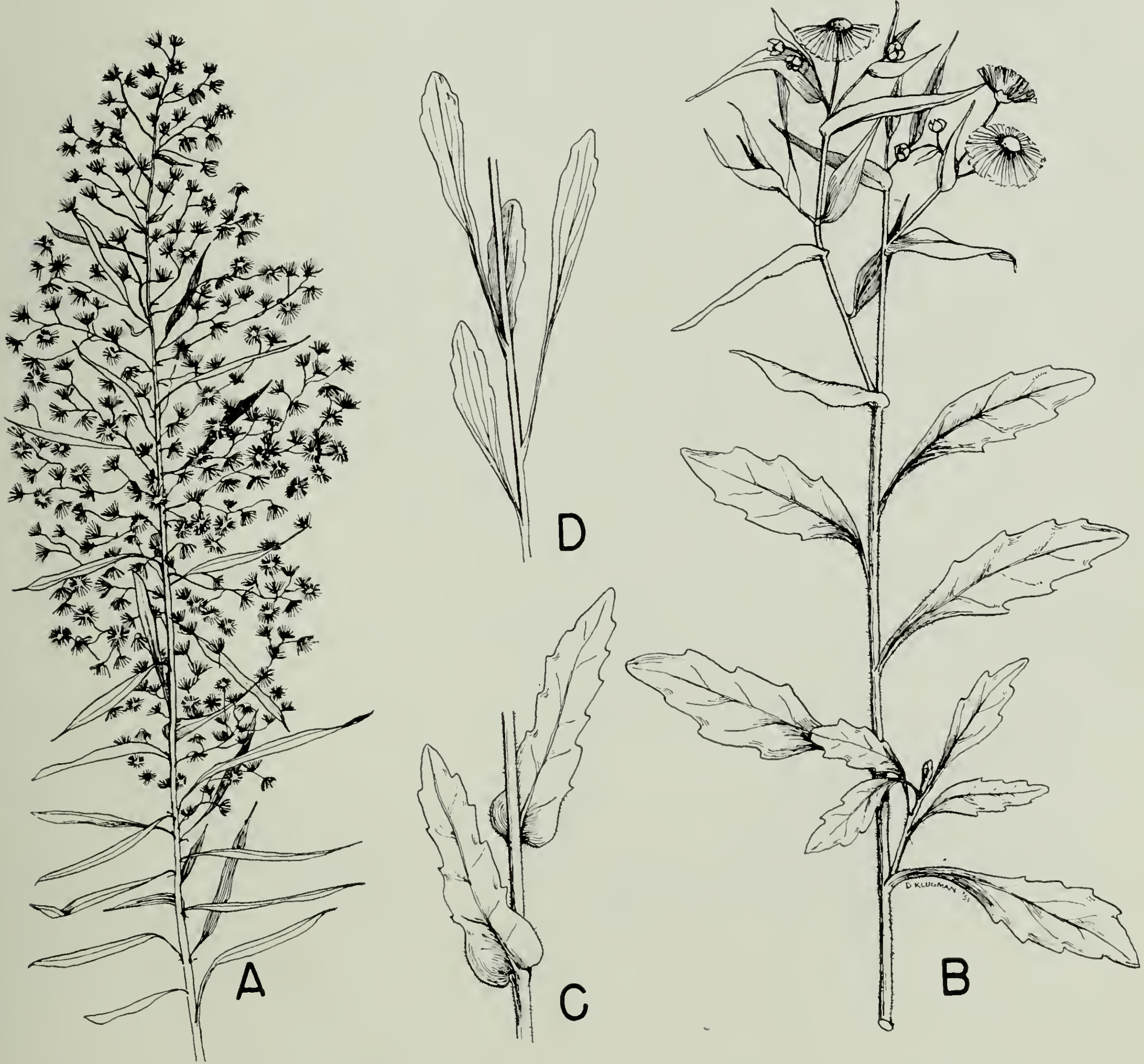


Fig. 47. A, Canada fleabane. B, Daisy fleabane. C, Leaf of Philadelphia fleabane. D, Leaf of daisy fleabane *Erigeron strigosus*.

have a similar shape, but are much shorter. The flowering top of the stem is very branching, and each branchlet terminates in a head of small, whitish flowers. When the plants are mature, a mass of brownish hairs has replaced the flowers, and these are attached to the seeds, and aid in their dispersal. Seed (Plate 23, no. 3).

Daisy Fleabane, *Erigeron annuus* (L.) Pers., grows about 2 feet high. The lower leaves are oval, coarsely toothed and have long, margined leaf-stalks. The upper stem-leaves are similar, but have shorter leaf-stalks (Fig. 47B). The whole plant is rather hairy. The upper part of the stem divides into numerous branchlets, each terminating in daisy-like heads. The flowers around the edge of the head may be whitish or purplish, but the central disc flowers are yellowish. The flowers are larger than those of Canada fleabane.

Daisy Fleabane, *Erigeron strigosus* Muhl. The leaves are more or less narrow elliptical, broad at the tips and tapering to long leaf-stalks (Fig. 47D). The flowers are similar to the other fleabanes and have white flowers around the edge of the head.

Philadelphia Fleabane, *Erigeron philadelphicus* L. The stem-leaves are oblong, without leaf-stalks and attached to the stem by a broad, almost clasping base (Fig. 47C). The flowers around the edge of the head are usually pinkish or purplish.

Common Ragweed, Roman wormwood, *Ambrosia artemisiifolia* L. and its var. *elatior* (Plate 12). This annual species varies from a few inches to three feet in height. The stem is simple or branching, and either smooth or hairy. The leaves are opposite or alternate, and very much dissected. Two kinds of flowers, male and female, occur on this plant. The male flowers are the drooping, small, greenish, pollen-producing flowers at the ends of the branches. The female flowers are the seed-forming flowers which occur between the upper leaf-stalks and the stem, or between the flowering branches and the stem. In late summer and early fall, the male flowers produce an enormous amount of pollen to which many people are allergic, and become afflicted with hay-fever. Seed (Plate 22, no. 13). Plants with less dissected leaves are also common.

Ragweed is recorded as harbouring the potato-aphid.

COMMON RAGWEED

AMBROSIA ARTEMISIIFOLIA L.

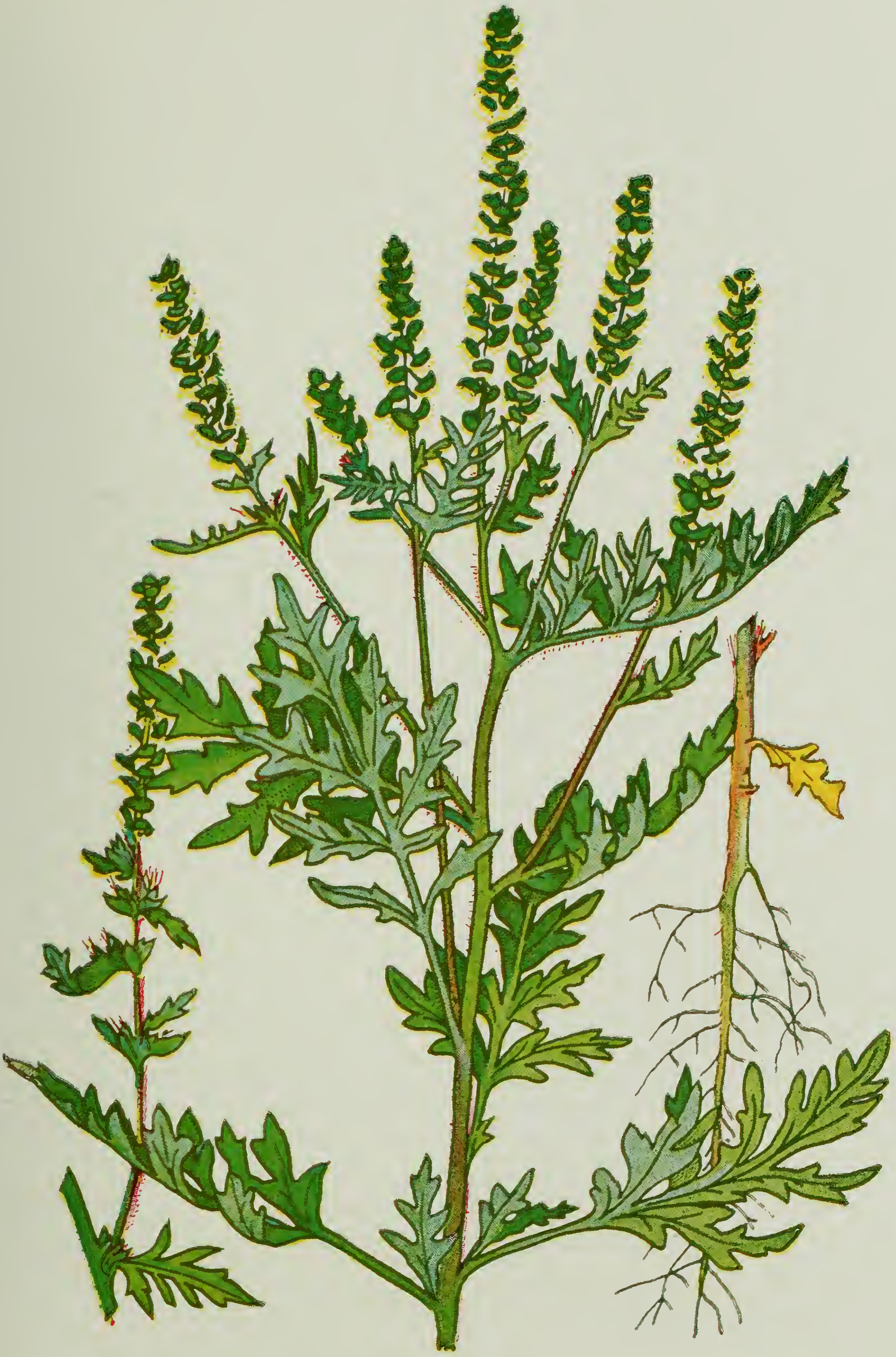


Plate 12. Common ragweed.

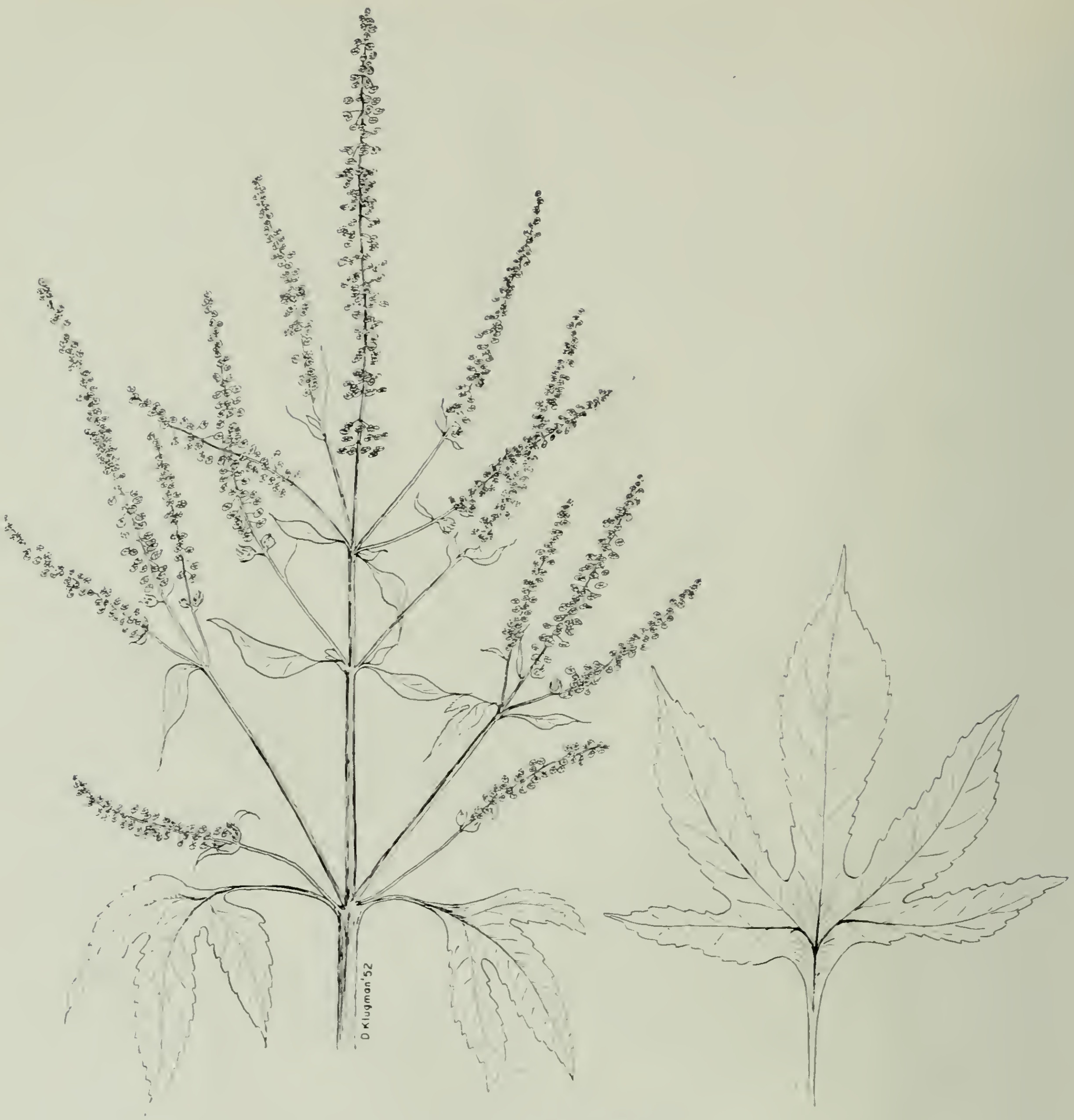
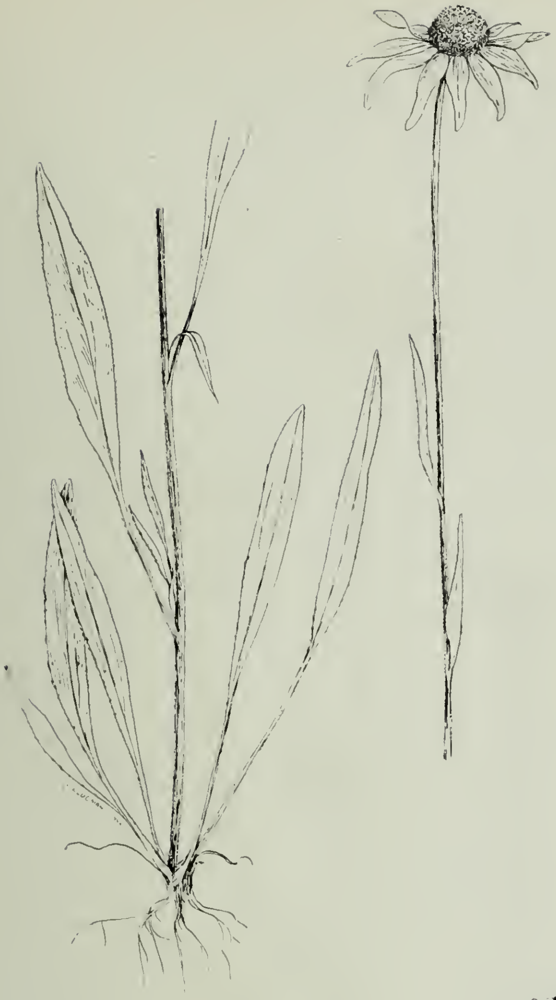


Fig. 48. Great ragweed.

Great Ragweed, *Ambrosia trifida* L. (Fig. 48), is also an annual, but is much larger than the previous species. The leaves are opposite, and the stem-leaves of the most common variety are usually 3-lobed. The flowers are in the same relative positions, and have the same general appearance as those of the common ragweed. The seeds are larger, but otherwise similar to those of the common ragweed (Plate 22, no. 14).

The forma *integrifolia* may also be found, but not as frequently as the typical species. It has the same general appearance as the great ragweed, but the leaves are not lobed.



Black-eyed Susan, Coneflower, *Rudbeckia serotina* Nutt. (Fig. 49). This is a rough perennial plant with broad, stalked, lower stem-leaves, and narrow upper leaves without stalks. The flowering heads are quite distinctive with their bright, orange-yellow flowers around the edge of the head, and dark purple or black, conical central disc. Seed (Plate 23, no. 1).

FIG. 49. Black-eyed Susan.

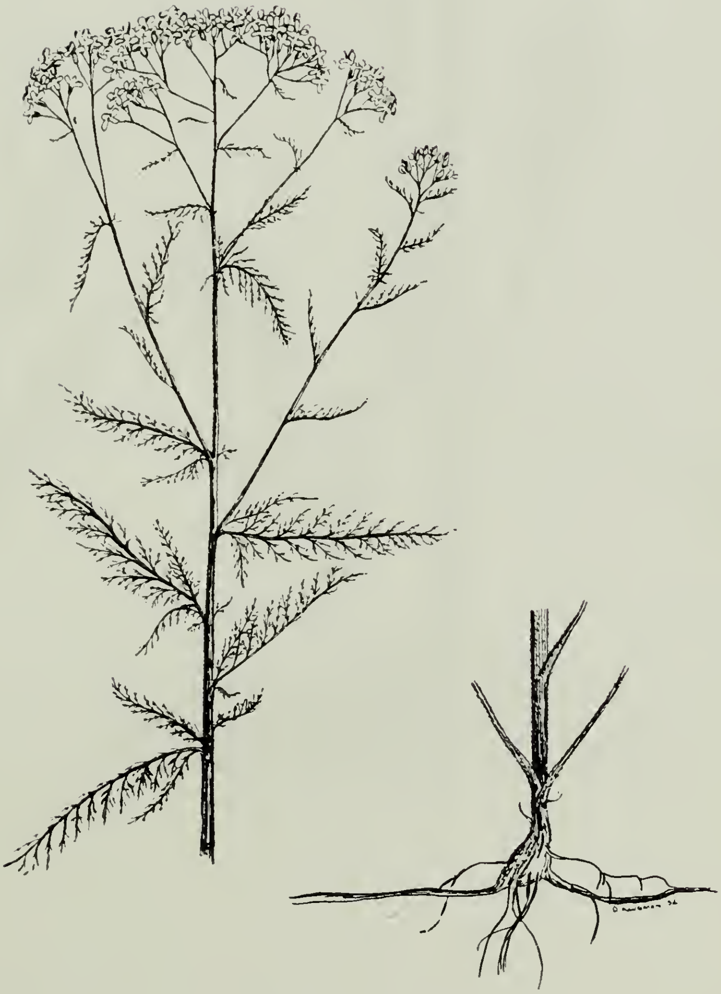


FIG. 50. Yarrow.

Yarrow, Milfoil, *Achillea millefolium* L. (Fig. 50), is a perennial, with a simple stem which branches at the top to form the flat-topped flower clusters. The leaves are very finely dissected, and both stems and leaves are finely hairy. The flowering tops have many small whitish or pinkish flowers. Seed (Plate 23, no. 8).

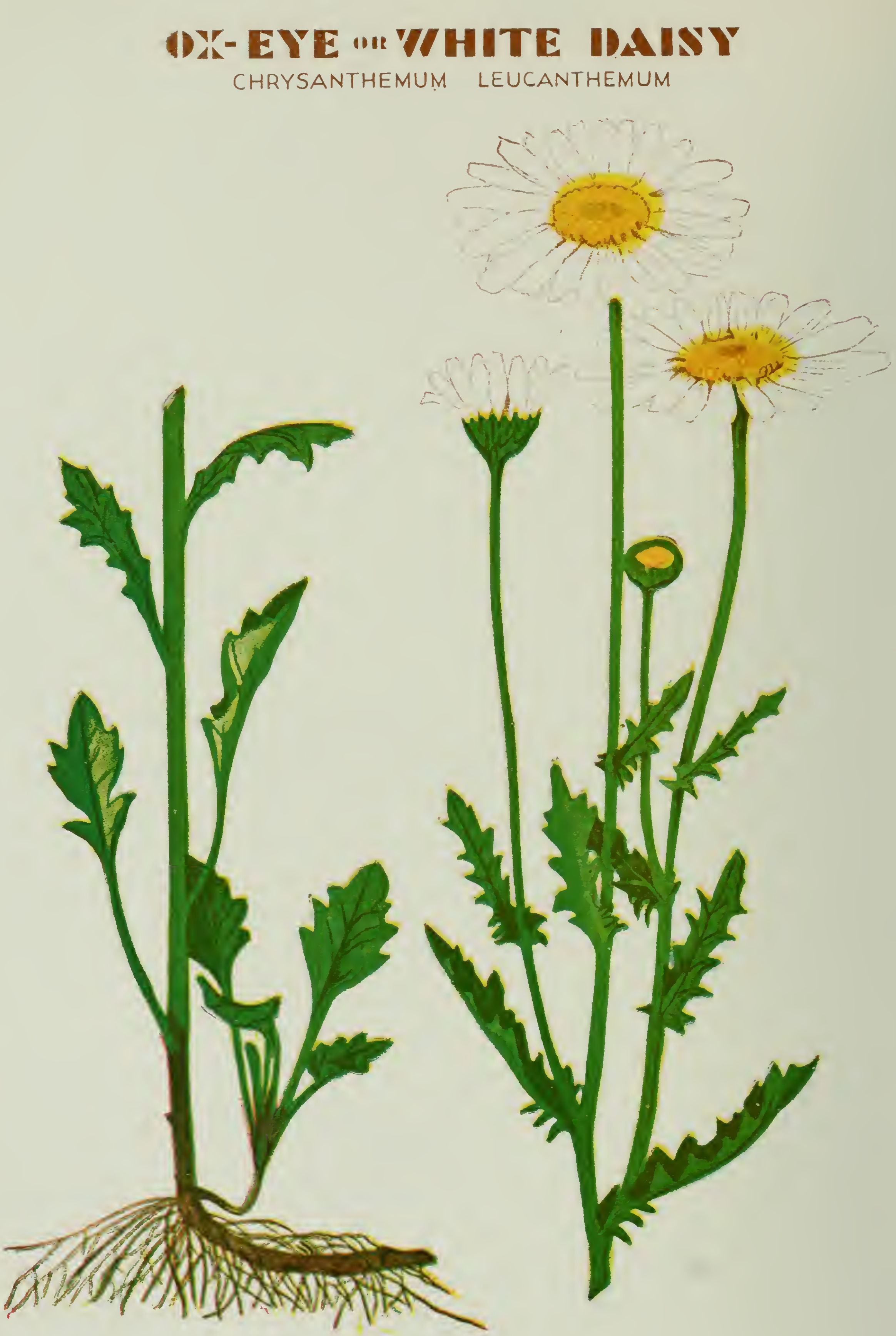


Plate 13. Ox-eye daisy.

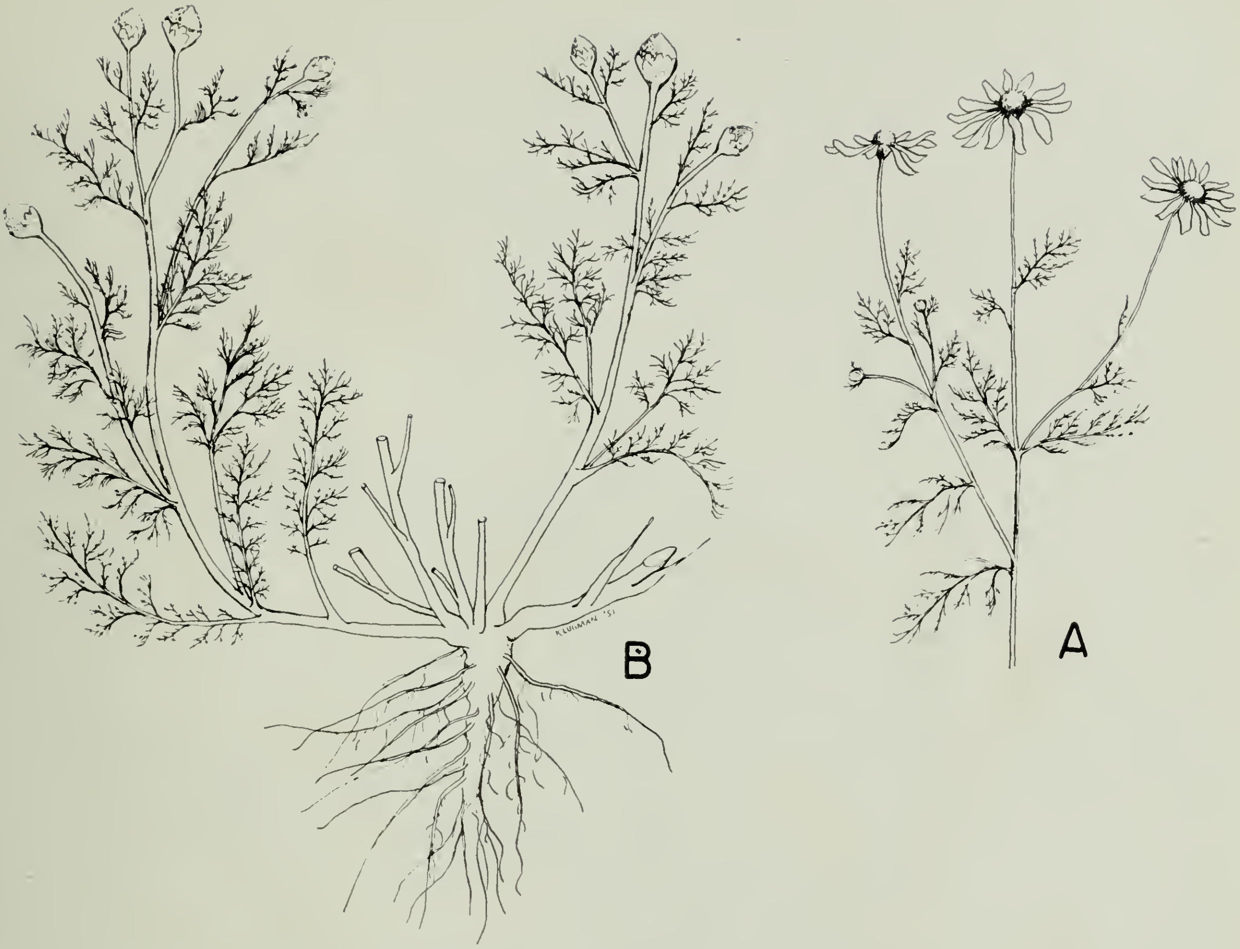


FIG. 51. A, Stinking mayweed. B, Pineapple-weed.

Stinking Mayweed, Dog fennel, *Anthemis cotula* L. (Fig. 51A), is a rather bushy, rank-smelling plant with very finely dissected leaves. The flowers have daisy-like heads with white flowers around the edge and yellow centres. Seed (Plate 23, no. 4).

A very similar looking plant, the **Pineapple-weed,** *Matricaria matricarioides* (Less.) Porter (Fig. 51B), has a pleasant pineapple odour. It lacks the conspicuous white flowers around the edge of the head which are present in stinking mayweed, and it has a yellowish-green cone-like centre. Seed (Plate 23, no. 5).

Ox-eye Daisy, *Chrysanthemum leucanthemum* L. and var. *pinnatifidum* Lecoq. and Lamotte (Plate 13). This is a perennial weed, with wide-spreading rootstocks and simple or branching stems. The lower leaves are deeply lobed, toothed and long stalked. The upper leaves are without stalks, and roughly toothed, particularly at their bases. The flowering head has a series of white flowers around the outside and a yellow disc. The seeds are black- and cream-striped and ridged (Plate 23, no. 6).

Common Tansy, *Tanacetum vulgare* L. (Fig. 52), is a tall, smooth, single-stemmed perennial arising from an underground rootstock. It is usually found along fences, roadsides, and in uncultivated ground. The leaves are much dissected and dark green. The flowering heads form dense, branching, flat-topped flower clusters. Each head consists of a button-like disc of small, yellow tubular flowers, but lacks any showy flowers around the edge of the head. Seed (Plate 23, no. 7).

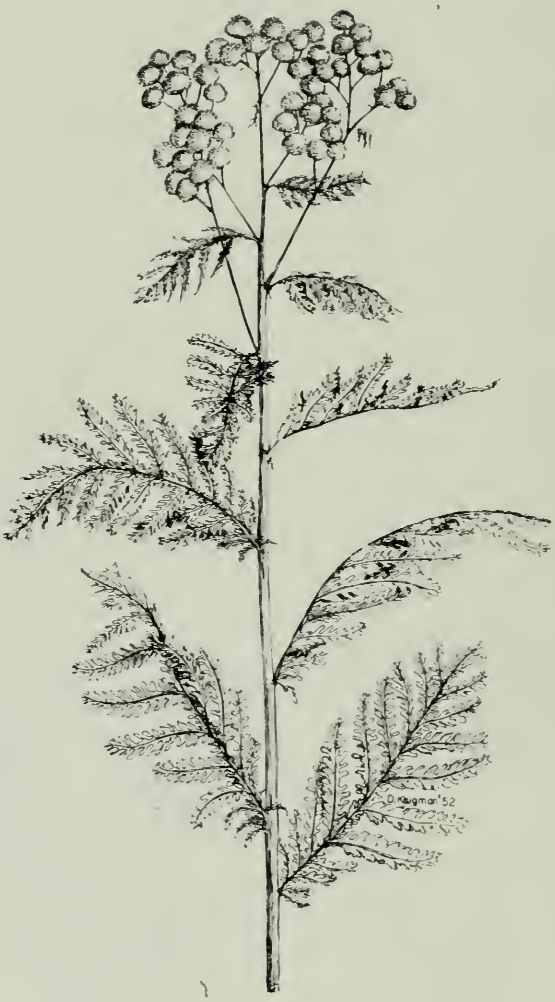


FIG. 52. Common tansy.

Common Burdock, *Arctium minus* (Hill) Bernh. (Fig. 53). A large coarse biennial weed of farmyards, fencerows and uncultivated areas. The first season it develops a large, branching root-system, and a rosette of long-stalked, large, rough, heart-shaped leaves with irregularly-toothed margins. In the second year, a tall, rough, leafy stem forms, and its branches terminate in heads of purplish flowers surrounded by hooked bracts. When the seed is mature, these heads break off easily from the stalks, and are carried away by adhering to animals or clothes of people coming in contact with them; thus the seeds are dispersed. Seed (Plate 23, no. 10).

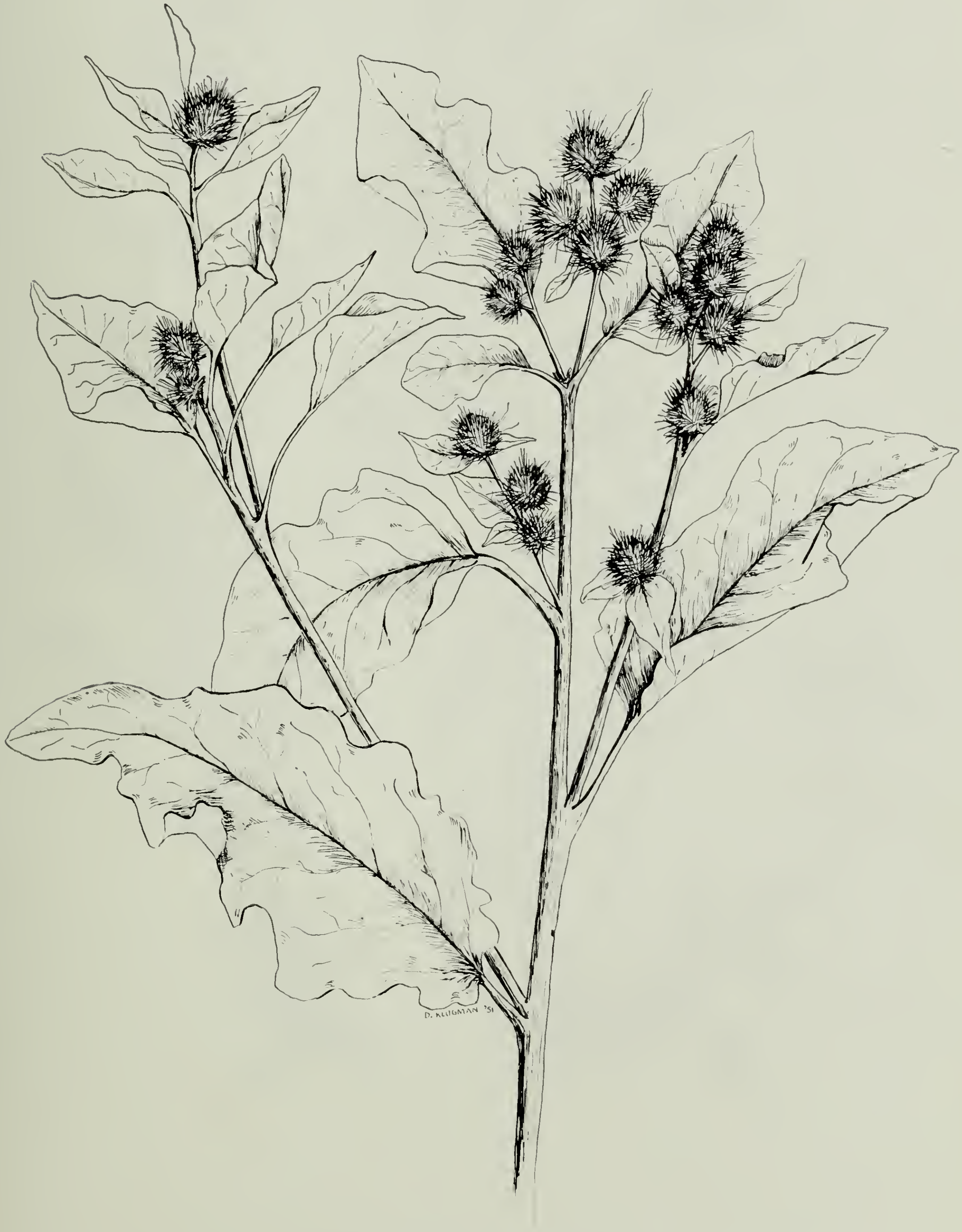


Fig. 53. Common burdock.

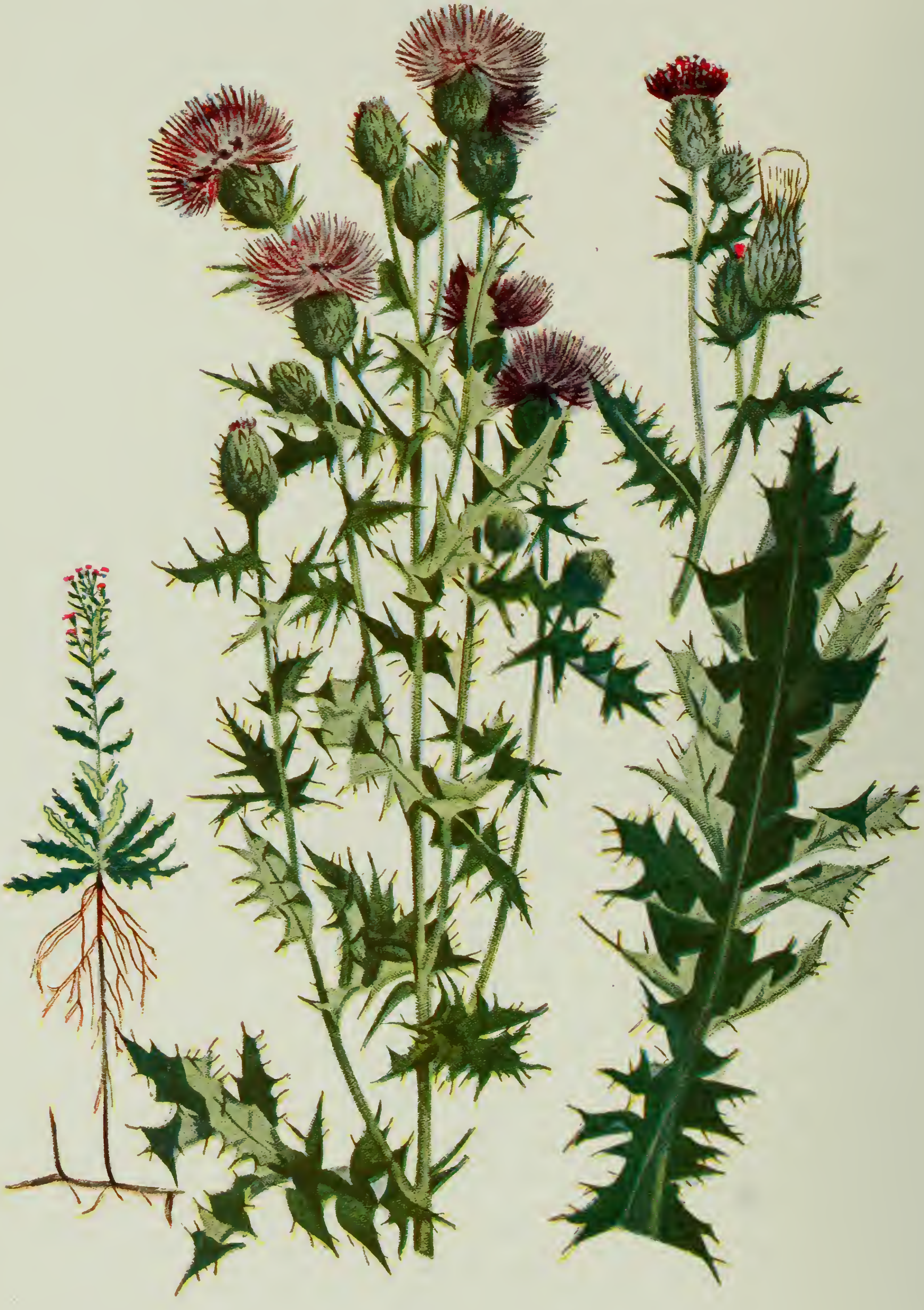


PLATE 14. Canada thistle.

The **Great Burdock,** *Arctium lappa* L., is also to be found. It is very large with large, greenish heads usually in groups of threes.

The stalk-borer finds burdock a suitable plant on which to live.

Canada Thistle, *Cirsium arvense* (L.) Scop. (Plate 14). A perennial developing from an extensively creeping rootstock. The branching stem has numerous, unstalked leaves. The leaves are deeply indented, and the margins have many, rigid, spine-tipped teeth. The flowering heads contain numerous, usually purplish flowers surrounded by spine-tipped bracts. The seeds have tufts of hairs which give them buoyancy, and they are dispersed by the wind. Seed (Plate 23, no. 13). Variations from the normal characteristics of this thistle are also known in Ontario.

Bull Thistle, *Cirsium lanceolatum* Hill (Fig. 54A). This thistle is a deep-rooted biennial 3 to 4 feet high with large upright heads and deep-purple flowers. The stems have prickly wings, and the leaves are woolly-hairy on the under surface. Seed (Plate 23, no. 12).

Nodding Thistle, *Carduus nutans* L., may be identified by its large, nodding heads, and deep-purple flowers (Fig. 54B). The upper surface of the leaves are a lighter green than those of the Bull thistle.

Very similar in appearance, but without the nodding heads, is the **Welted Thistle,** *Carduus acanthoides* L. This may be common in some areas.

Scotch Thistle, *Onopordum acanthium* L. (Fig. 54C), is a very tall, branching biennial. The stems have broad, spiny wings, and the leaves are deeply lobed and have spiny margins. The whole plant is densely white woolly-hairy. The flowers are large and purple. Seed (Plate 23, no. 14).

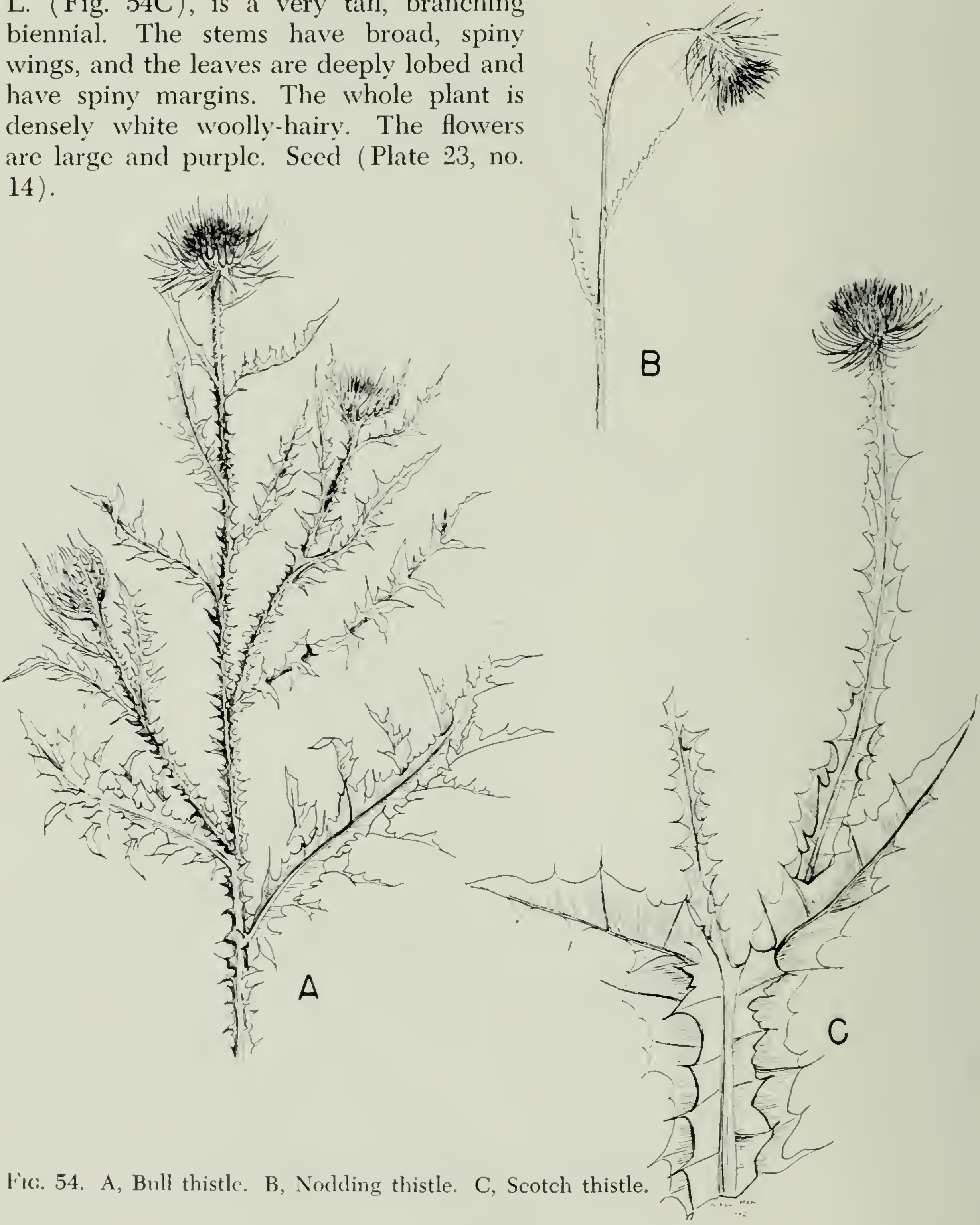


Fig. 54. A, Bull thistle. B, Nodding thistle. C, Scotch thistle.

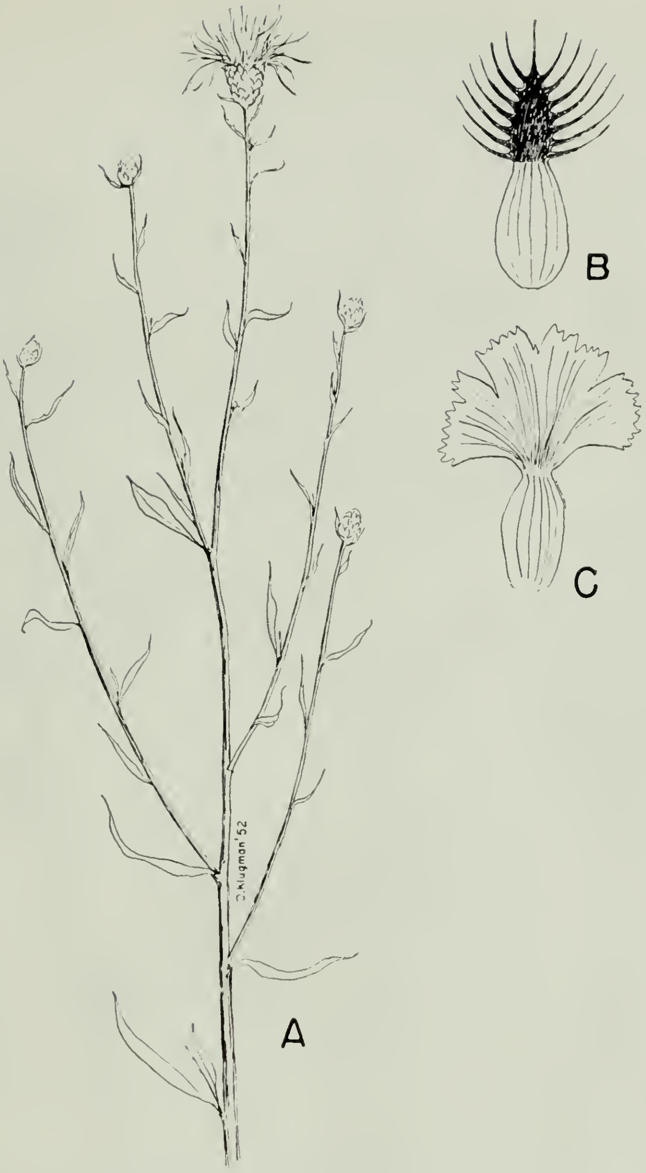


FIG. 55. A, Knapweed. B, Bract of black knapweed. C, Bract of *Centaurea jacea*.

Knapweeds, *Centaurea* spp. (Fig. 55A). The common wild species of knapweeds are rather difficult to separate. The figure shows one common species, *C. jacea.* The most distinguishing characteristics are the thistle-like heads with purplish flowers, and the peculiar bracts under the heads. These are lacy-fringed, or spiny at the tips. The appearance of the tips of the bracts is often used to separate different species. Figure 55C shows a middle bract of *C. jacea,* and figure 55B shows a middle bract of *C. nigra,* the black knapweed. Seed (Plate 23, no. 15).

A third common species is *C. maculosa* which has much divided leaves.

Chicory, *Cichorium intybus* L. (Plate 15), is a very common biennial or perennial with a large deep-penetrating root, and tall, branching, rather ragged looking stems. The leaves close to the ground are somewhat like those of the dandelion. The stem leaves are much shorter. They do not have a leaf-stalk, and do not clasp the stem. The flowering heads are about one inch in diameter, and develop in the axils of the small leaves. They have many blue flowers which are usually open only for a short time. Seed (Plate 23, no. 17).

CHICORY
CICHORIUM INTYBUS L.

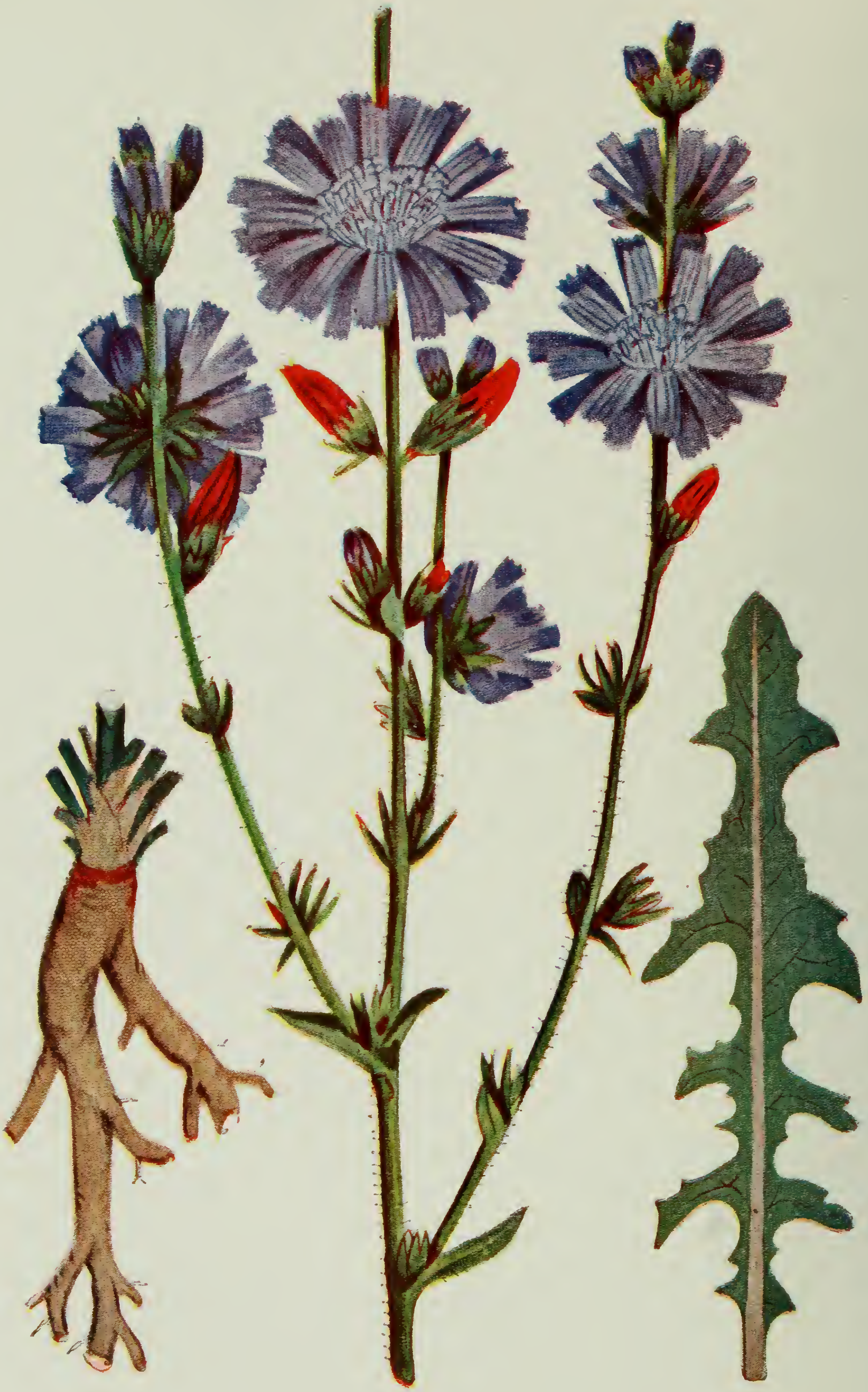


Plate 15. Chicory.

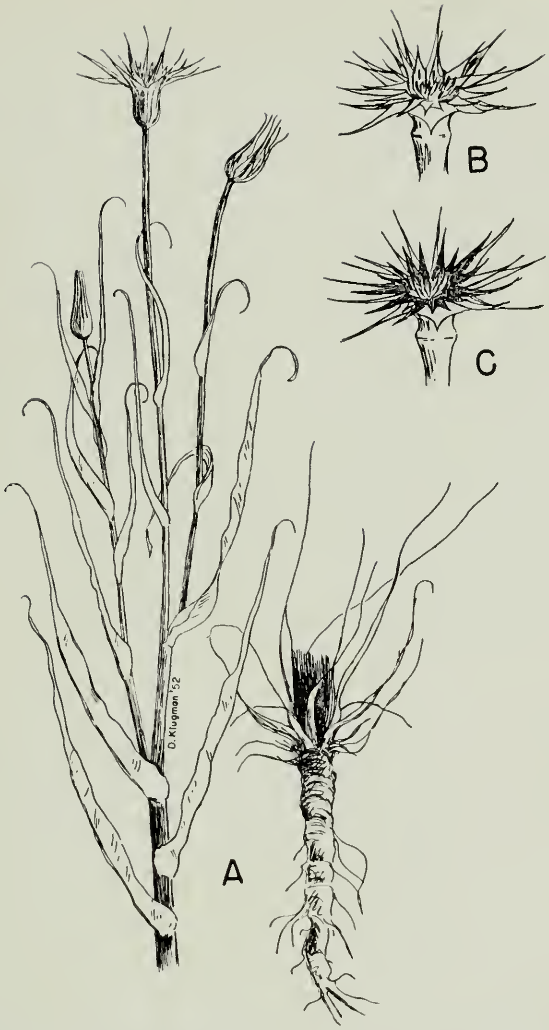


Fig. 56. A, Yellow goat's-beard. B, Head of *Tragopogon dubius*. C, Head of salsify.

Yellow Goat's - Beard, *Tragopogon pratensis* L. (Fig. 56A), is usually a biennial weed with large taproot and tall, smooth stem 2 to 3 ft. high with milky juice. The leaves are broad at the base, and taper to a long, wrinkled, curled point. The large heads have many golden-yellow flowers. The flowers open in the morning, and are usually closed by noon. The head remains closed until seeds are mature, when it opens into a large, fluffy ball with long whitish plumes attached to the seeds. Seed (Plate 24, no. 5).

A second yellow goat's-beard *Tragopogon dubius* Scop., is often mistaken for the previous species. However, it is easily distinguished by the shorter and heavier stems, the long taper-pointed, straight-tipped leaves, a distinct swollen area in the stem below the heads, and the lemon-yellow flowers which are shorter than the green bracts (Fig. 56B). The fruiting heads are about twice the size of those of the first species, and the hairs are a dirty gray colour. The plants prefer sandy or well drained soils. A small variety of this species is also to be found. It is from 6 to 12 inches high, single-stemmed, and has smaller flowers.

Salsify, Oyster plant, *Tragopogon porrifolius* L., is very similar in appearance to the Yellow Goat's Beard, but is taller, and has a slightly whitish appearance. The stem is swollen below the heads. The flowers are purple and shorter than the green bracts under them (Fig. 56C), and the hairs at the ends of the seeds are brownish in colour.

Dandelion, *Taraxacum officinale* Weber. This weed is so well known that a description is unnecessary. Seed (Plate 24, no. 3). The **Fall Dandelion,** *Leontodon autumnalis,* should not be confused with the common dandelion because of the similarity in names. It is easily distinguished from the common dandelion by its smaller leaves, and also by the smaller flowering heads. The stems are branched at the top, and are not hollow and fleshy.

Perennial Sow Thistle, *Sonchus arvensis* L. (Fig. 57). This is a widely distributed perennial, with an extensive underground rootstock from which the tall stems arise. The basal leaves are large, deeply lobed, spiny-toothed and clasping the stems. The upper leaves may be quite short, and clasping the stems. The terminal lobe of all of the leaves is usually long-pointed. The flower bearing branches are long, hairy, and with few leaves. The heads of bright or orange-yellow flowers are about 1½ inches in diameter, and surrounded by numerous bracts which have glandular, sticky hairs. The seeds are brown, and have several longitudinal ridges. The ridges are prominent and clearly cross wrinkled (Plate 24, no. 2). Several variations from the typical species occur. One frequent variety lacks the sticky hairs on the upper part of the stem and flower head.

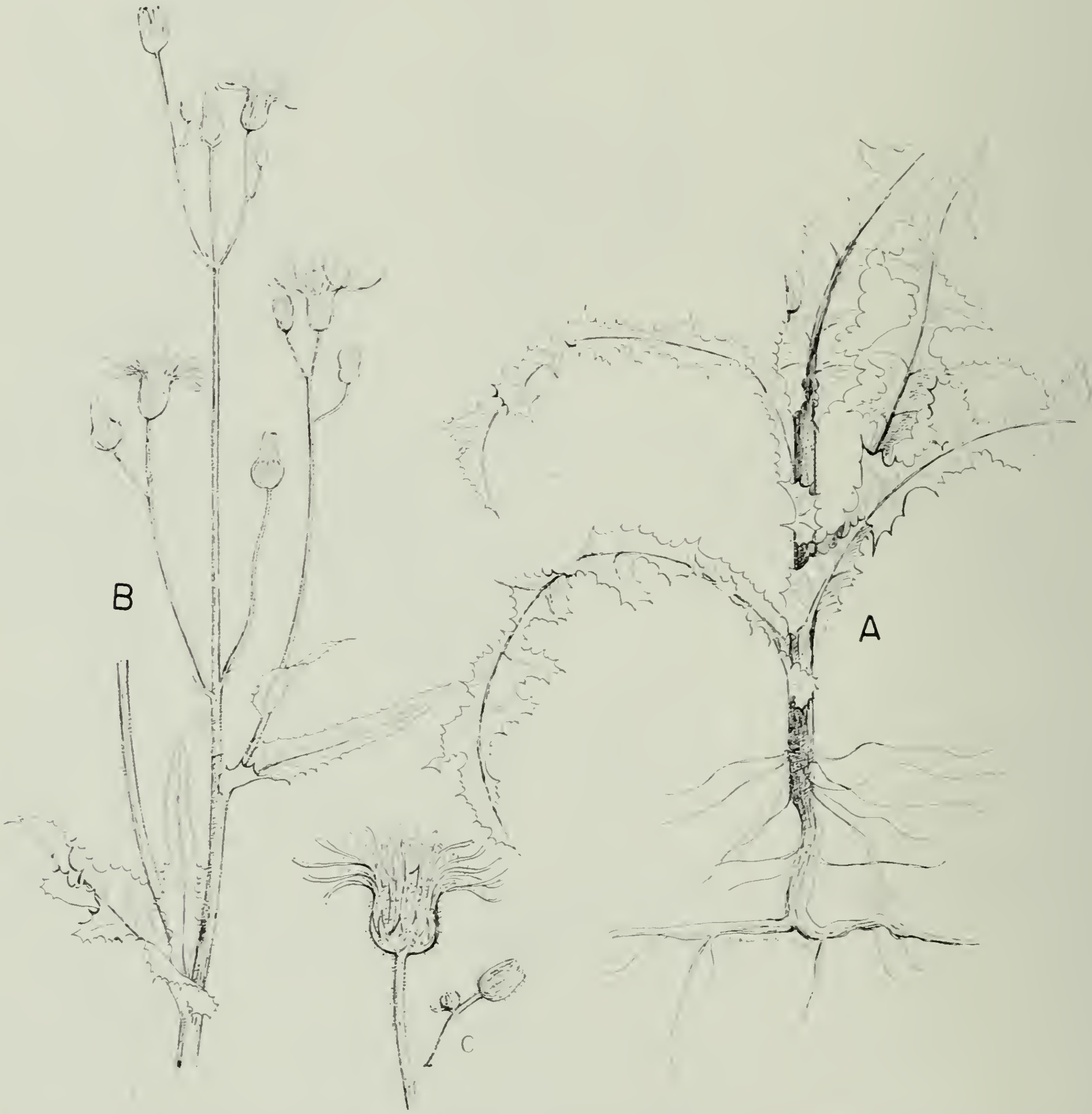


Fig. 57. Perennial sow thistle. A, Lower portion of stem. B, Flowering portion of stem. C, Flowering head.

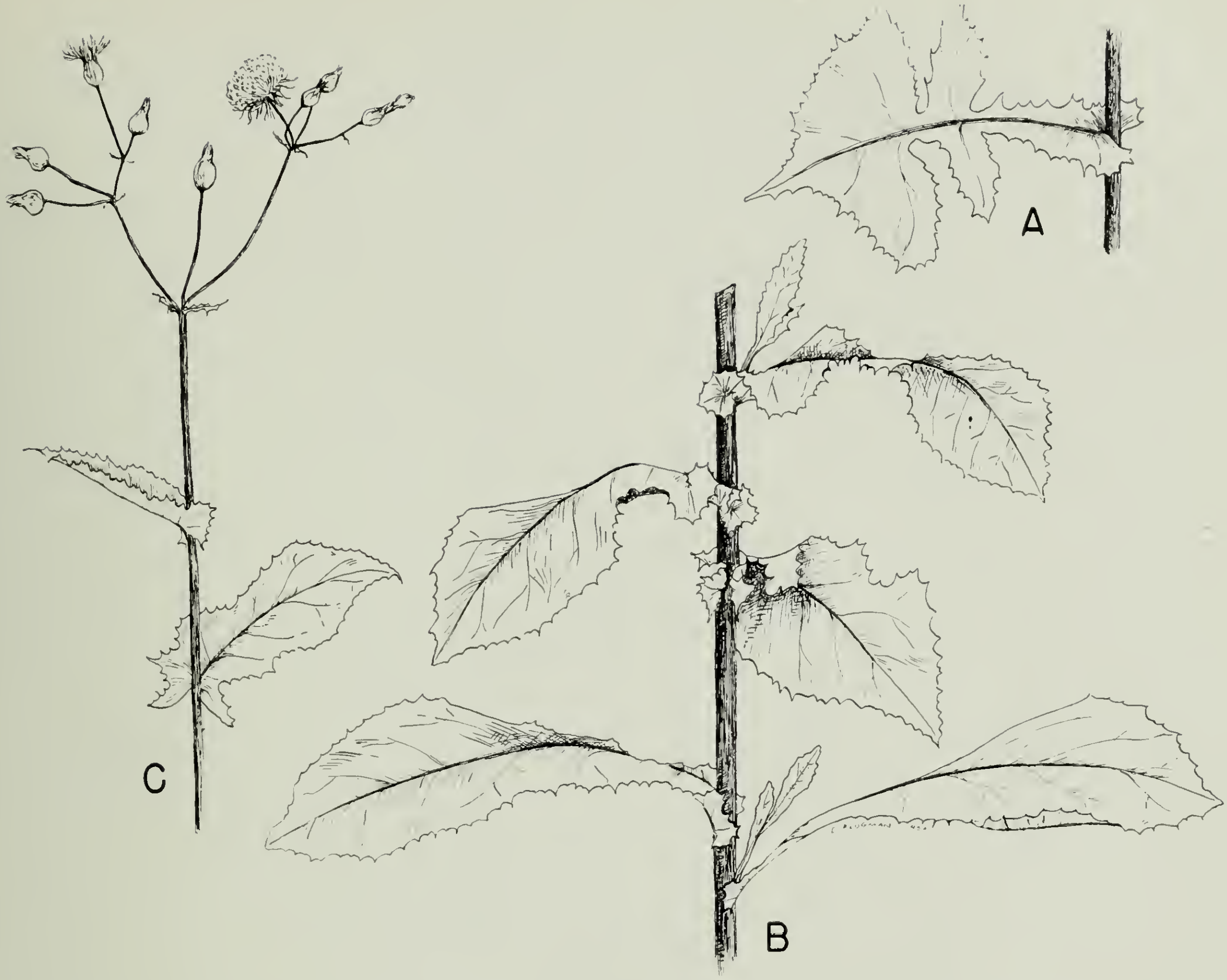


FIG. 58. A, Leaf of common annual sow thistle. B, and C, Spiny annual sow thistle.

Common Annual Sow Thistle, *Sonchus oleraceus* L., is an annual, with a well developed taproot. The soft, smooth leaves are deeply indented, but the terminal lobe is short, broad and rounded or triangular in shape (Fig. 58A). The flowers are pale or lemon yellow, and less than one inch in diameter. The stems and the bracts are smooth (no hairs). The seeds are much similar in size and shape to the perennial sow thistle. The longitudinal ridges are not as prominent and there are numerous transverse wrinkles or lines between the ridges.

Spiny Annual Sow Thistle, *Sonchus asper* (L.) Hill, is distinguished by its large, smooth leaves, with broad, rounded, clasping base, pointed tips and sharply toothed margins which are not as deeply lobed as the margins of the common annual. (Fig. 58B and C). The seeds differ from either the perennial or the common annual sow thistles. They are much flattened, more oval, and with 3 or 5 longitudinal ridges, otherwise smooth.

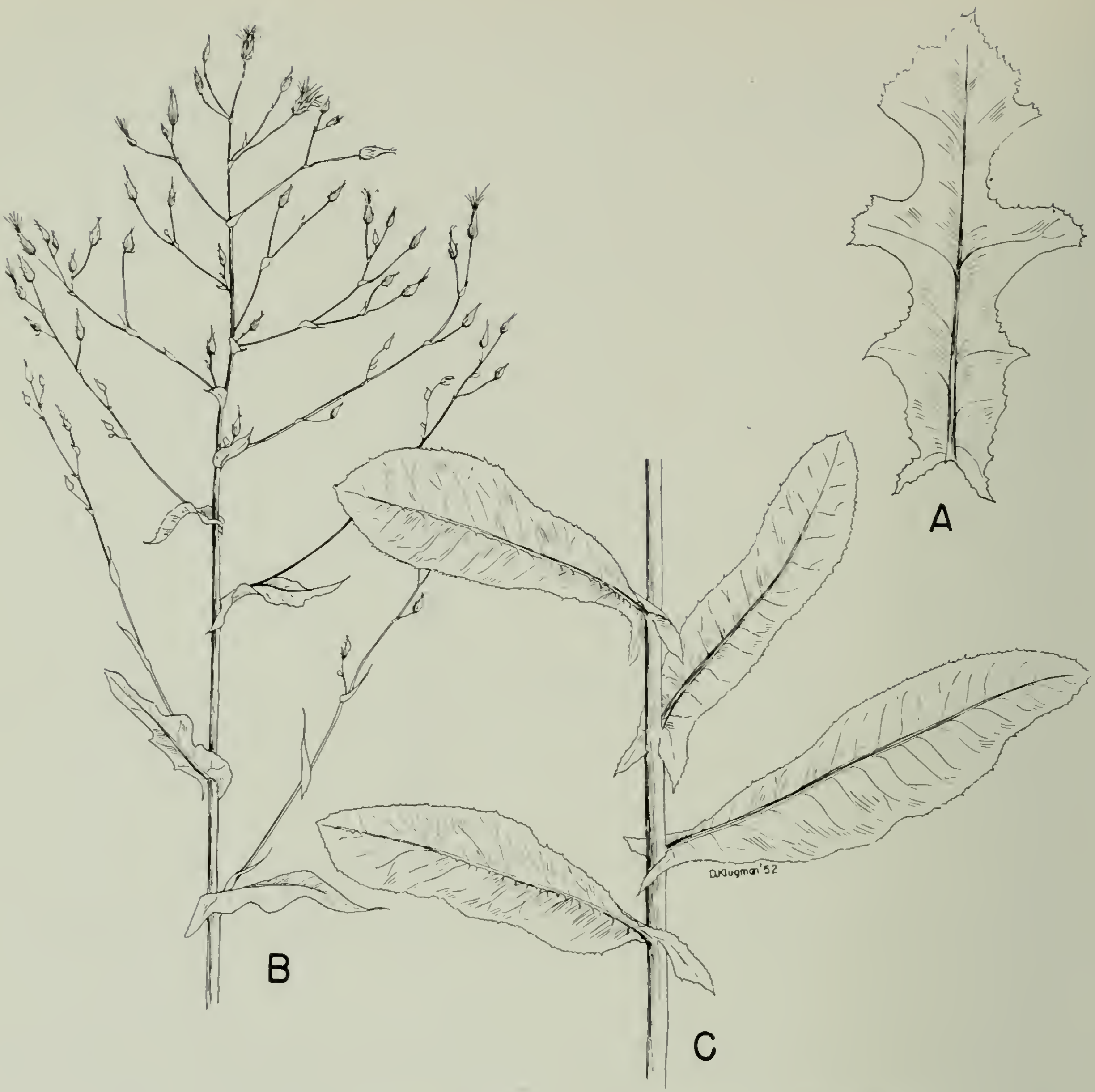


FIG. 59. A and B, Prickly lettuce. C, Leaf of forma *integrifolia.*

Prickly Lettuce, *Lactuca scariola* L. (Fig. 59), is an annual or biennial plant, with a long, deep-growing taproot and tall, unbranched stem. The leaves are deeply lobed (Fig. 59A - B), more or less dandelion-like, and clasping the stem by a heart-shaped base. They may have spiny margins, and the lower surface of the main veins of the leaves have rather stiff spines. The leaf-blades are most frequently in a vertical position, instead of horizontal as in most plants. The flowering part consists of many heads of small yellow flowers.

There is a form of prickly lettuce, forma *integrifolia,* which does not have the deeply lobed leaves, or only the basal ones are toothed (Fig. 59C). In some places this may be more common than the species. Seed (Plate 24, no. 4).

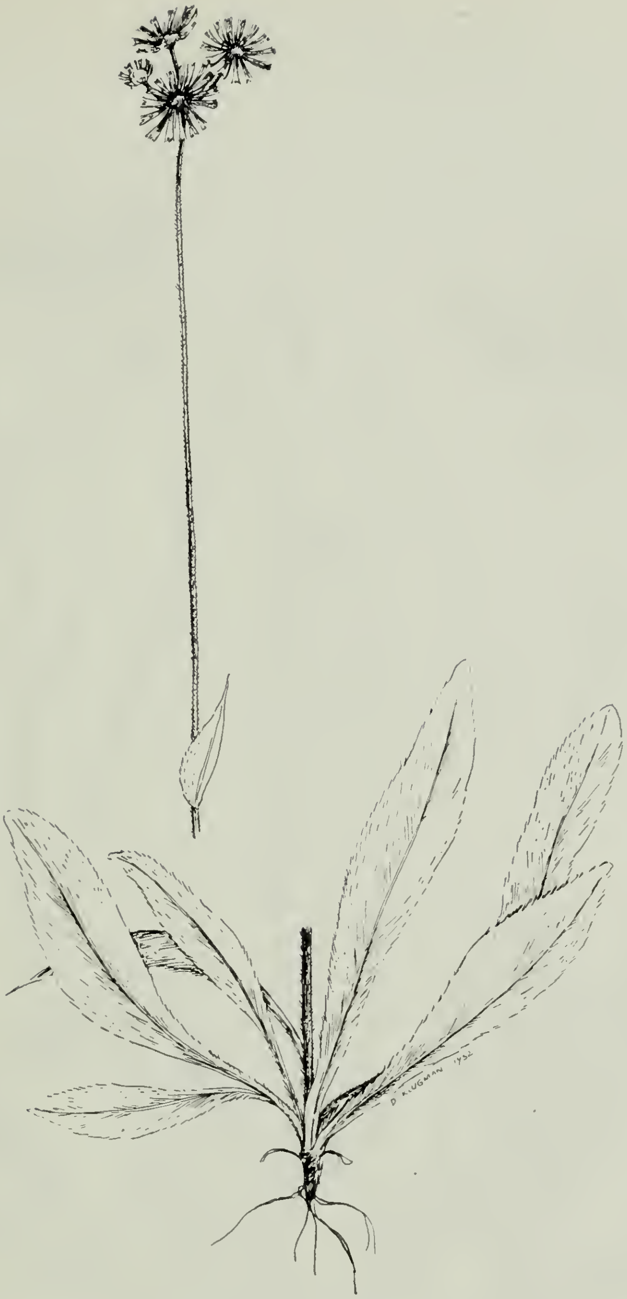


Fig. 60. Orange hawkweed.

Orange Hawkweed, Devil's paint brush, *Hieracium aurantiacum* L. (Fig. 60), is a perennial, which reproduces by seed and by runners. It is quite distinctive with its dark, orange-coloured heads of flowers which develop in a cluster on a hairy, nearly leafless stem, one to two feet in height. At the base of the flowering stem is a rosette of broad-tipped hairy leaves. Seed (Plate 24, no. 5).

Yellow Hawkweeds, King devils, *Hieracium* spp., may be roughly divided into two groups: — those which have leafy flowering stems, and those which have flowering stems without leaves. Most of our common weedy species belong to the latter group. They have rosettes of leaves on the surface of the ground, and from a rosette arises the usually leafless flowering stem. This divides at the top and produces few to many small, yellow heads of flowers. (Plate 16).

KING DEVIL

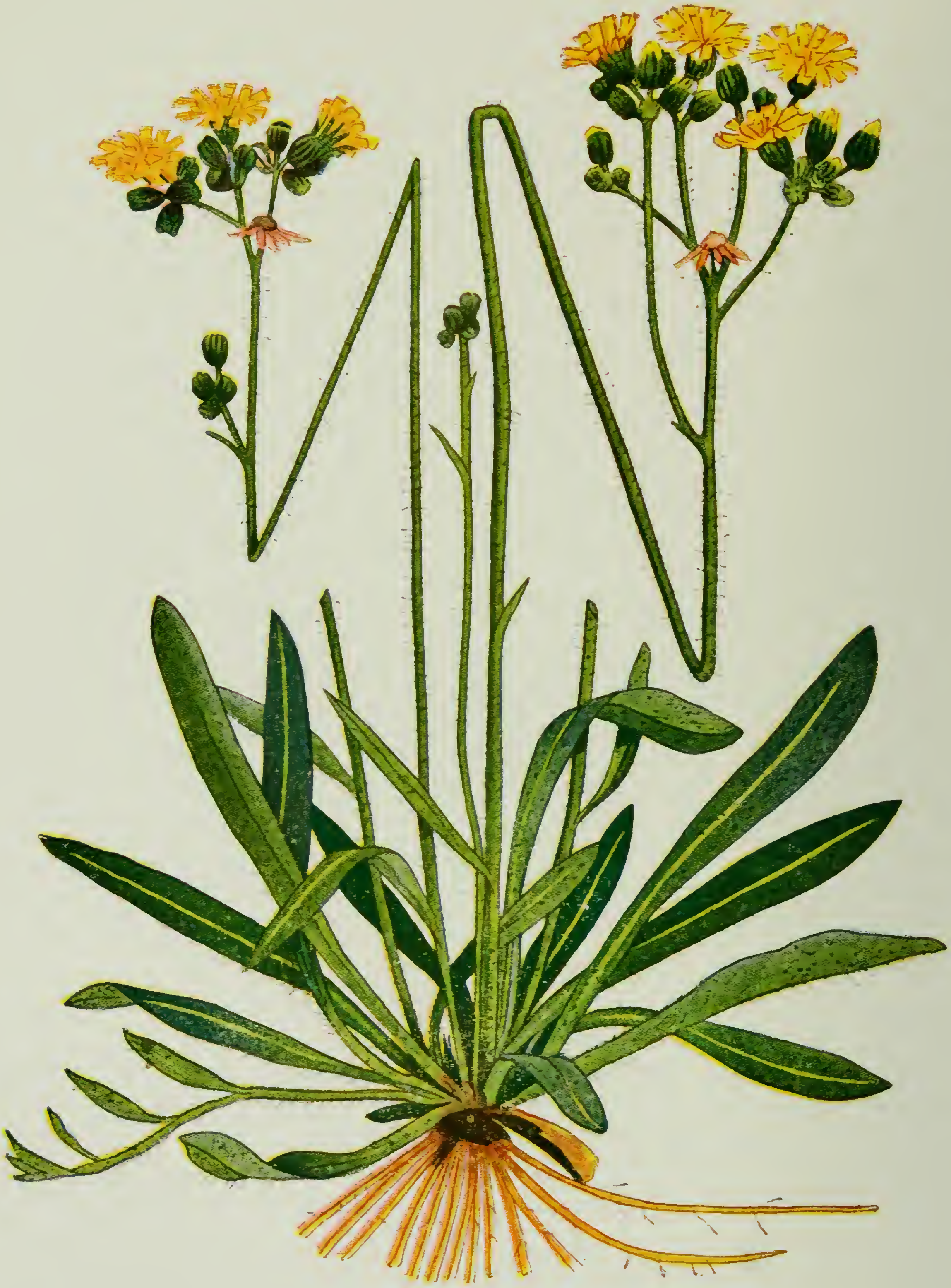


PLATE 16. Yellow hawkweed.

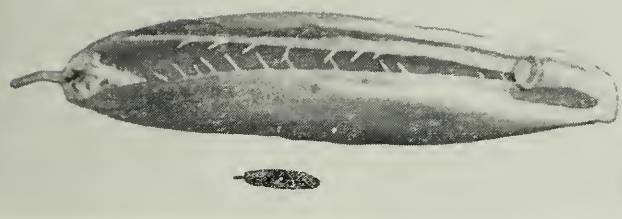
NOTES

PLATE 17

Photographs by F. H. MONTGOMERY

1. CHESS, *Bromus secalinus L.* Dull yellow to gray; margins of inner bract with stiff hairs; awn short or none.
2. COMMON DARNEL, *Lolium temulentum* L. Dull yellow to gray; awned or awnless.
3. COUCH OR QUACK-GRASS, *Agropyron repens* (L.) Beauv. Greenish-gray colour; margin of inner bract with short hairs.
4. BARNYARD-GRASS, *Echinochloa crusgalli* (L.) Beauv. Yellowish to gray; strongly rounded on the back; back and margins of outer bracts bristly-hairy; inner seed-coverings smooth, glossy and faintly lined.
5. WILD OAT, *Avena fatua* L. Gray to brown in colour; the basal sucker-like scar surrounded by stiff hairs; back of grain covered with fine hairs; awn bent at right-angles and lower part twisted.
6. JOHNSON GRASS, *Sorghum halapense* (L.) Pers. Glossy; light to dark brown; two small stalks at base of grain closely pressed against grain.
7. YELLOW FOXTAIL, *Setaria glauca* (L.) Beauv. Yellow, green or brownish with numerous coarse transverse wrinkles on the rounded side. Hull covers less than half of the grain.
8. GREEN FOXTAIL, *Setaria viridis* (L.) Beauv. Colour varies with the ripeness of the seeds, but most frequently they are brownish, mottled, with very fine transverse wrinkles on the rounded side. Hull covers all of the grain.
9. SANDBUR, *Cenchrus longispinus* (Hack.) Fern. Greenish-yellow to gray; easily identified by its long, sharp, stiff spines.
10. CRABGRASS, *Digitaria* spp. Green, brown or purple; strongly ribbed and slightly hairy. See p. 9 for differences between two weedy finger-grasses.
11. OLD WITCH-GRASS, *Panicum capillare* L. Outer bracts often remain attached; grain greenish-gray to brown; shiny with light lines on the rounded side.

GRASS SEEDS



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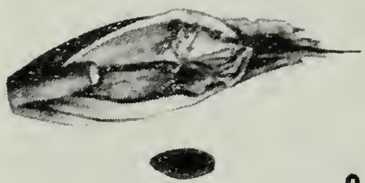

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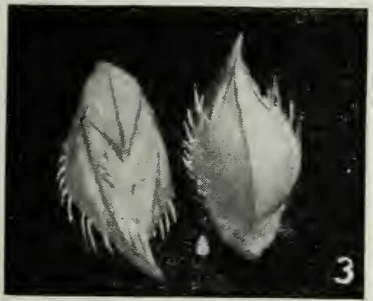

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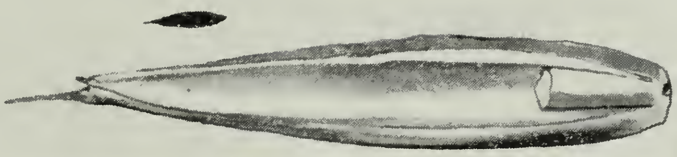

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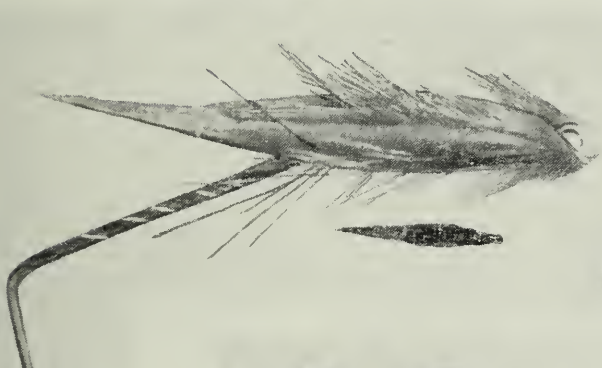

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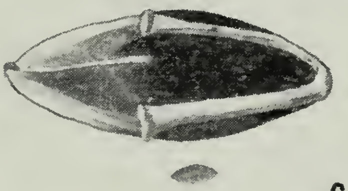

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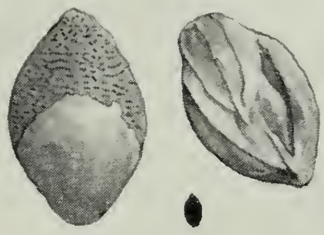

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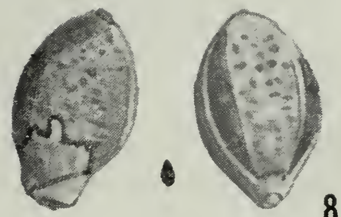

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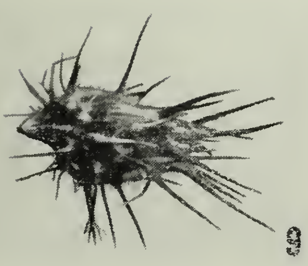

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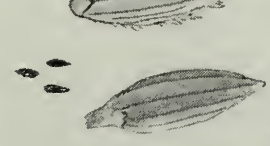

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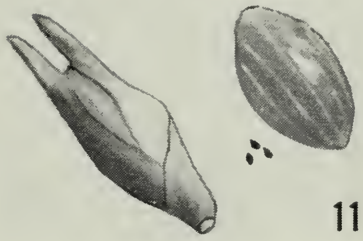

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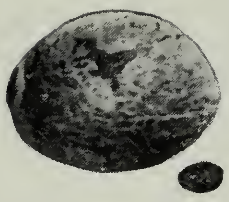
PLATE 18

1. Hemp, *Cannabis sativa* L. The seed is large with a grayish-brown slightly mottled covering, which is finely net-veined.
2. Curled dock, *Rumex crispus* L. Shiny brown and smooth; symmetrically beechnut-shaped.
3. Sheep sorrel, *Rumex acetosella* L. Seed usually covered by flower parts with fine veins and is dull brown; seed itself is shiny brown; beechnut-shaped.
4. Wild buckwheat, *Polygonum convolvulus* L. Dull black, beechnut-shaped; hull brown.
5. Lady's thumb, *Polygonum persicaria* L. Shiny black, more or less flattened or lens-shaped.
6. Lamb's quarters, *Chenopodium* spp. The shiny black, lens-shaped seeds are usually covered by a grayish coating which has a circular opening at the top showing the enclosed black seed.
7. Spreading orache, *Atriplex patula* and varieties. Seeds covered by triangular bracts; seeds rounded, lens-shaped, shiny black.
8. Russian pigweed, *Axyris amaranthoides* L. Two types of seed are found; one has a grayish-brown and lightly streaked thin covering which extends over the upper end of the seed forming two wings at one end. The second kind does not have the wings.
9. Russian thistle, *Salsola kali* var. *tenuifolia* Tausch. Seed more or less snail-shell shaped; a thin membranous coating covers the coiled embryo; top of seed concave with small projection in centre.
10. Redroot pigweed, *Amaranthus retroflexus* L. Shiny black, egg shaped and flattened.
11. Purslane, *Portulaca oleracea* L. Shiny black; covered with small tubercles resembling those of the cockles.
12. Spurry, *Spergula arvensis* L. Dull black, lens-shaped with a pale, winged margin; surface covered with brownish gland-like projections.
13. Common chickweed, *Stellaria media* (L.) Cyrill. Dark gray or brown.
14. Common mouse-ear chickweed, *Cerastium vulgatum* L. Brown; somewhat triangular with fine tubercles.
15. Purple cockle, *Agrostemma githago* L. Dull purplish-black; sides flattened or concave; regular rows of rather large, sharp tubercles.
16. Red cockle, *Lychnis dioica* L. Gray to black; prominent scar at base.

Knotweed,
Goosefoot,
Amaranth,
Purslane families.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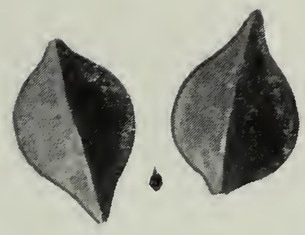
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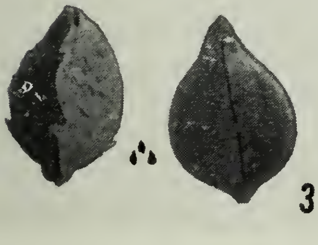
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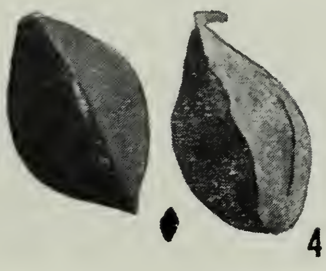
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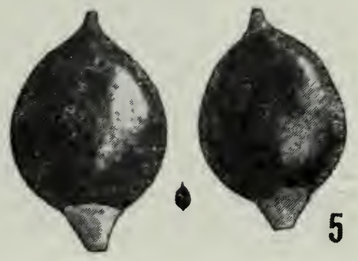
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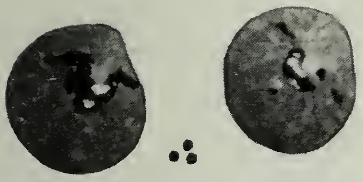
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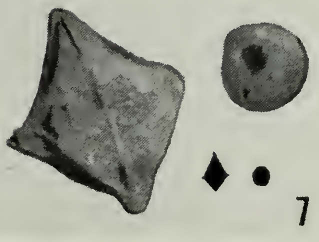
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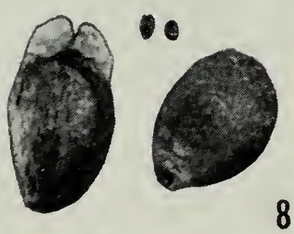
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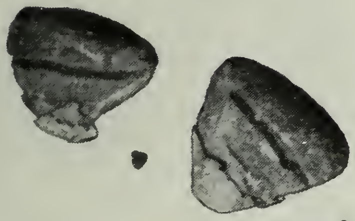
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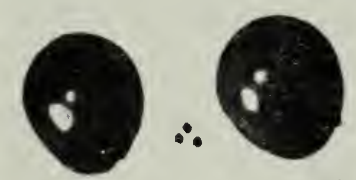
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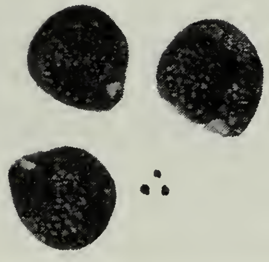
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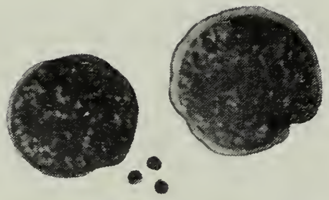
Pink family.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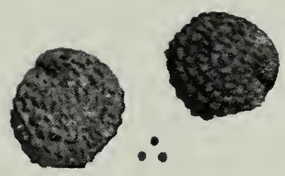
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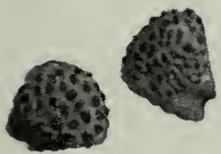
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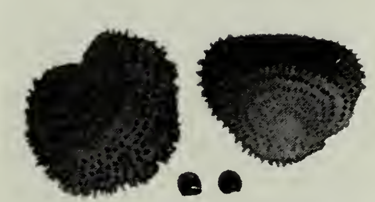
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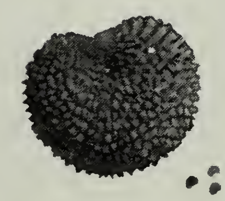
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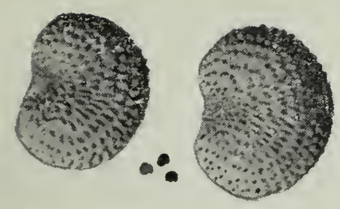
PLATE 19

1. White cockle, *Lychnis alba* Mill. Light gray colour; tubercles less numerous than in bladder campion or night-flowering catchfly.
2. Bladder-campion, *Silene cucubalus* Wibel. Dark gray; difficult to separate from night-flowering catchfly, but usually many of the seeds are more or less triangular in shape as in the left seed of the figure.
3. Forked catchfly, *Silene dicotomota* (L.) Gray. Tubercles dark-tipped and less numerous and more sharply pointed than in night-flowering catchfly.
4. Night-flowering catchfly, *Silene noctiflora* L. Very similar to bladder campion but tubercles black-tipped and less sharply pointed.
5. Bouncing bet, *Saponaria officinalis* L. Dull black; very finely roughened by small blunt tubercles.
6. Cow cockle, *Saponaria vaccaria* L. Dull black; spherical surface minutely roughened.
7. Tall buttercup, *Ranunculus acris* L. Brown to nearly black, dull.
8. Hoary alyssum, *Berteroa incana* (L.) DC. Dull gray to brown; lens-shaped; margin slightly winged.
9. Penny-cress or stinkweed, *Thlaspi arvense* L. Purplish-black; surfaces with distinctive ridges.
10. Field pepper-grass, *Lepidium campestre* (L.) R. Br. Dark gray; surface finely roughened; white-tipped at base.
11. Common peppergrass, *Lepidium densiflorum* Schrad. Reddish-brown; slightly wing-margined.
12. Hoary cress, *Cardaria draba* (L.) Desv. Dark reddish-brown; surface slightly roughened.
13. Shepherd's purse, *Capsella bursa-pastoris* (L.) Medic. Reddish-brown with slightly pitted surface.
14. Small-seeded false flax, *Camelina microcarpa* Andrz. Dark reddish-brown; finely roughened surface.
15. Western or large-seeded false flax, *Camelina sativa* (L.) Crantz. Larger and pale reddish-brown; surface finely pitted.
16. Ball mustard, *Neslia paniculata* (L.) Desv. A yellow seed is enclosed within a ball shaped pod. The seed pod is grayish and its surface coarsely veined. It is usually found in this form in grain.
17. Wild radish, *Raphanus raphanistrum* L. The seeds remain enclosed in the pod which fractures into small segments. The seed is brownish and its surface finely pitted or netted.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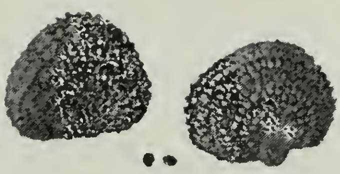
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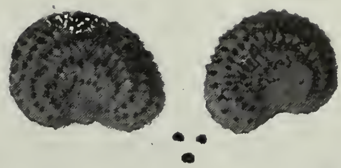
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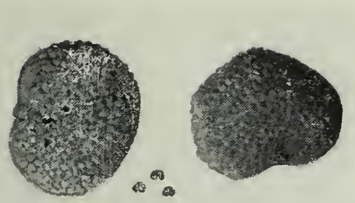
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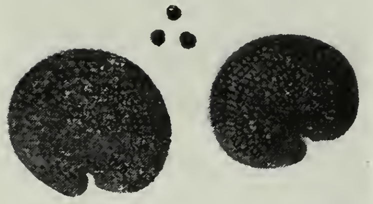
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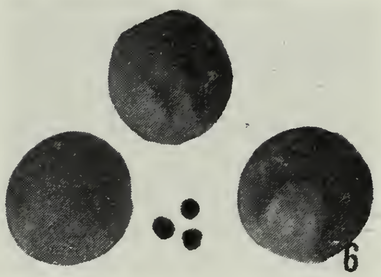
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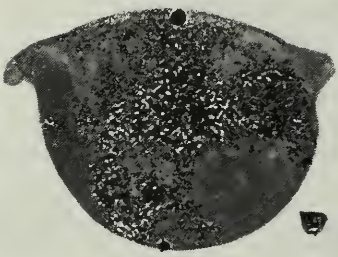
Buttercup,
Mustard families.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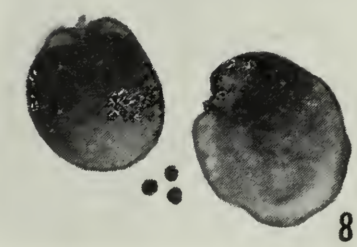
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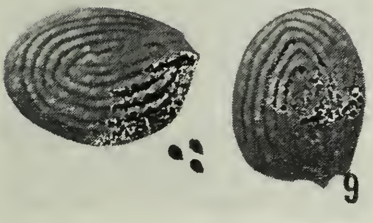
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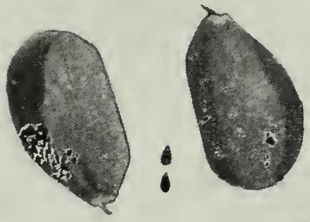
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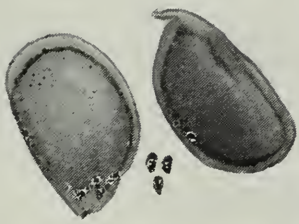
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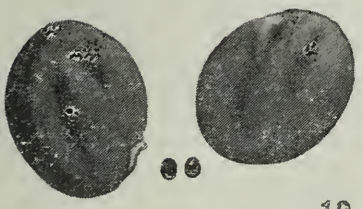
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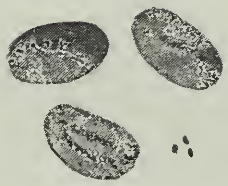
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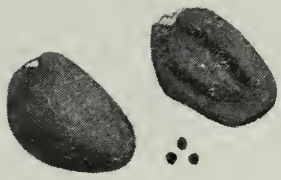
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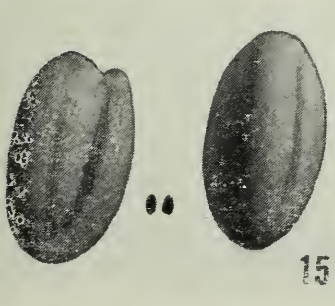
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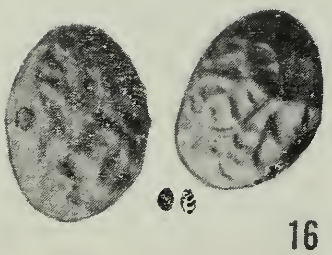
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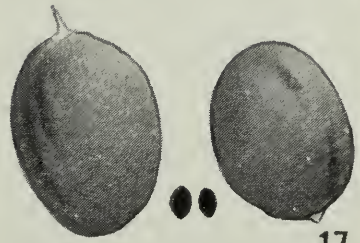
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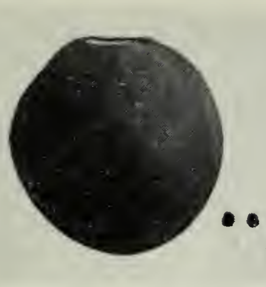
PLATE 20

1. Wild mustard, *Brassica kaber* (DC.) L. C. Wheeler var. *pinnatifida* (Stokes) L. C. Wheeler. Reddish-brown to black, and surface very finely pitted.
2. Indian mustard, *Brassica juncea* (L.) Coss. Dark gray and finely pitted.
3. Black mustard, *Brassica nigra* (L.) Koch. Gray, brown; finely pitted.
4. Dog mustard, *Erucastrum gallicum* (Willd.) O. E. Schulz. Reddish-brown; very finely net-veined.
5. Hare's-ear mustard, *Conringia orientalis* (L.) Dumort. Dark gray or brown; pointed at one end and slightly roughened.
6. Hedge mustard, *Sisymbrium officinale* (L.) Scop. Grayish-brown.
7. Tumbling mustard, *Sisymbrium altissimum* L. Light brown or yellowish.
8. Flixweed, Tansy mustard, *Descurania sophia* (L.) Webb. Light reddish-brown without black tip.
9. Wormseed mustard, *Erysimum cheiranthoides* L. Reddish-brown with black tip.
10. Yellow rocket, *Barbarea vulgaris* R. Br. Glossy, gray to brown; surface slightly roughened.
11. Rough-fruited cinquefoil, *Potentilla recta* L. Dark gray; ridges prominent and sharp; margins slightly winged.
12. Rough cinquefoil, *Potentilla norvegica* L. Light gray; ridges rounded, and less prominent.
13. Yellow avens, *Geum* spp. Dark brown; hairy on the margins and sometimes on the sides.
14. Black medick, *Medicago lupulina* L. Seed covering black and ridged; calyx persistent; one seed per pod; seed yellow, egg shaped and smooth with a projection on one side.
15. Leafy spurge, *Euphorbia esula* L. Gray, slightly mottled with a light or dark ridge along one side.
16. Round-leaved mallow, *Malva neglecta* Wallr. Seed-covering gray; flattened on the sides; minutely hairy on the curved surface. Usually found in this condition.
17. St. John's-wort, *Hypericum perforatum* L. Glossy, dark brown; surface roughened; end of seeds pointed.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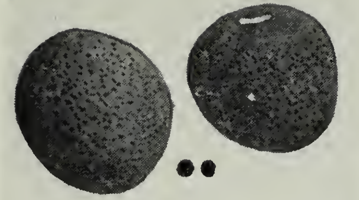
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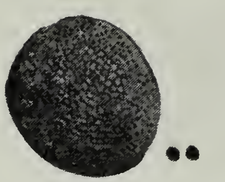
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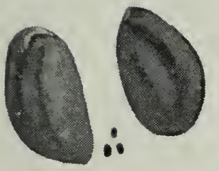
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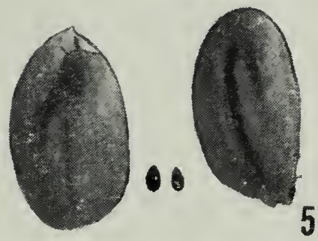
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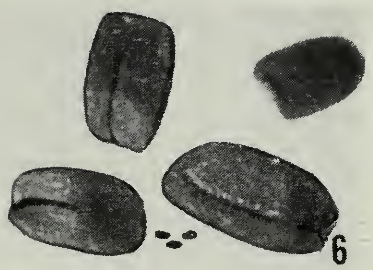
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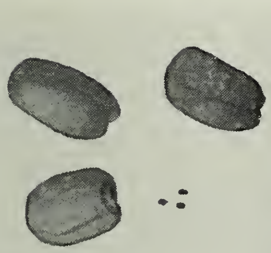
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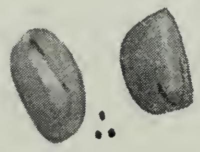
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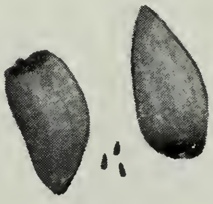
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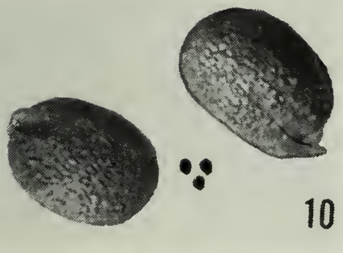
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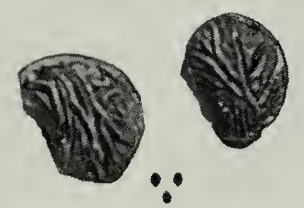
Rose,
Legume,
Spurge,
Mallow,
St. John's-wort families.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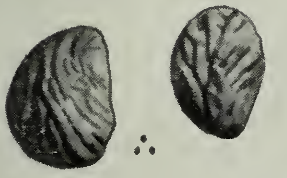
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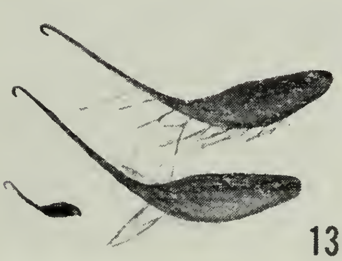
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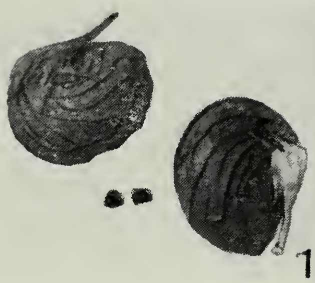
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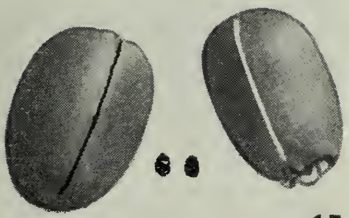
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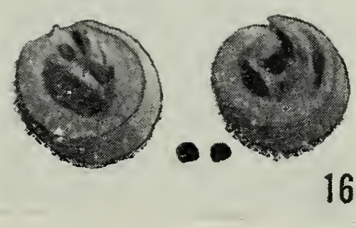
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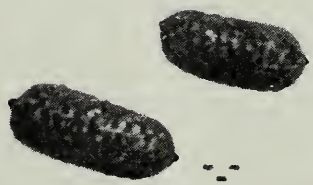
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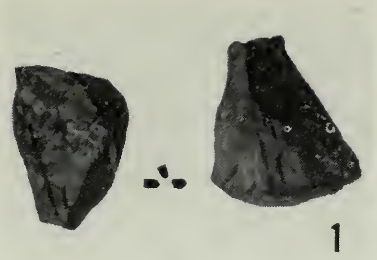
PLATE 21

1. EVENING PRIMROSE, *Oenothera* spp. Variable in size and shape; dark reddish-brown to black; surface roughened.
2. WATER HEMLOCK, Spotted cowbane, *Cicuta maculata* L. Brown ridges with black furrows.
3. CARAWAY, *Carum carvi* L. Light coloured ridges, with wide, brown furrows.
4. WILD PARSNIP, *Pastinaca sativa* L. Grayish-green with dark lines and rounded ridges.
5. WILD CARROT, *Daucus carota* L. Grayish; 4 rows of spines on each half of seed.
6. COMMON MILKWEED, *Asclepias syriaca* L. Dark brown; flattened.
7. FIELD BINDWEED, *Convolvulus arvensis* L. Gray to black; slightly roughened; reddish depression at lower end.
8. HEDGE BINDWEED, *Convolvulus sepium* L. Seeds rounded; dark gray to black. Much larger than field bindweed.
9. DODDER AND ALFALFA SEED, *Cuscuta* spp. (right). Small seeds gray to brown; surface slightly roughened.
10. BLUEWEED, *Echium vulgare* L. Gray or brown; rounded outer surface roughened; inner surface angular.
11. CORN GROMWELL, *Lithospermum arvense* L. Grayish; surface rough and dark pitted; two small protuberances on lower end.
12. HOUND'S TONGUE, *Cynoglossum officinale* L. Grayish with stiff spines terminating in star-shaped hooks.
13. STICKSEED, *Lappula echinata* Gilib. Gray to black; outer surface with spines terminating in star-shaped bristles; inner surface triangular and without hooks.
14. BLUE VERVAIN, *Verbena hastata* L. Brownish; more or less three-sided; margins slightly winged.
15. HEAL-ALL, *Prunella vulgaris* L. Glossy brown; white-tipped and with 4 pairs of longitudinal dark lines.

Primrose,
Parsley,
Milkweed families.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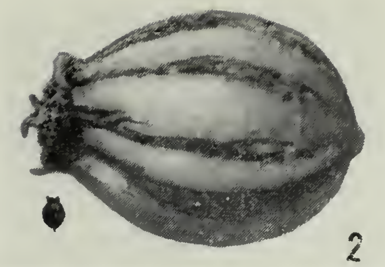
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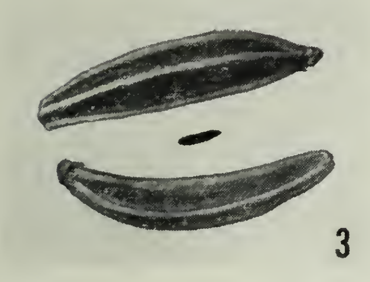
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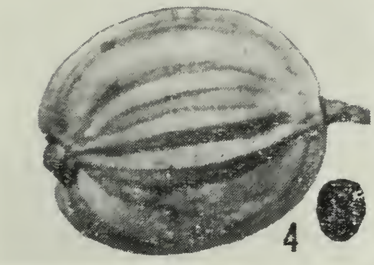
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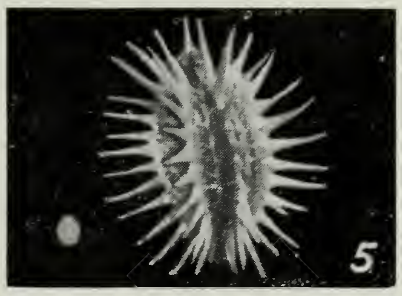
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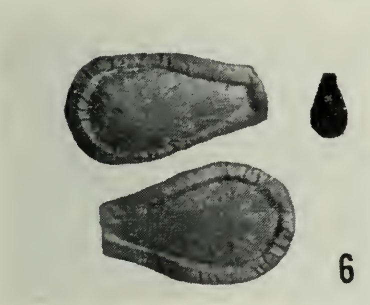
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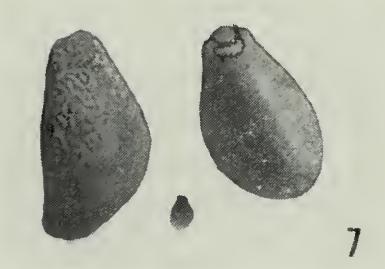
Bindweed,
Borage families.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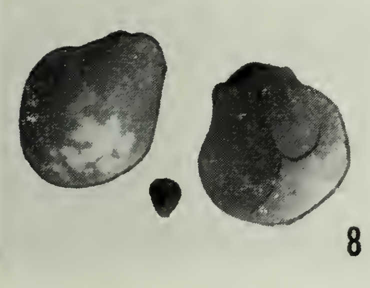
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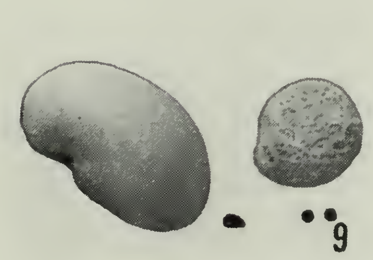
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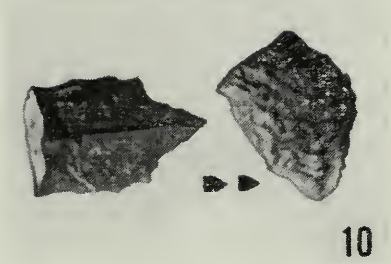
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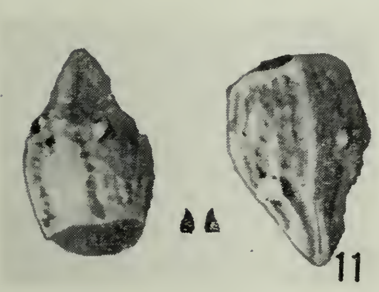
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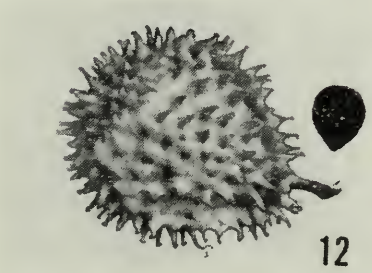
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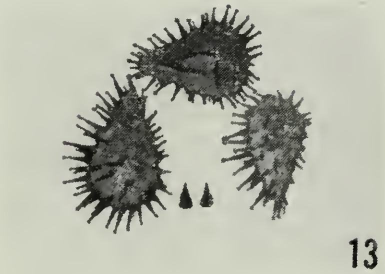
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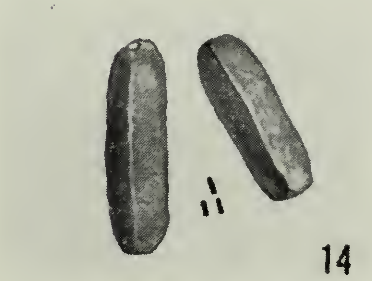
Vervain,
Mint,
Potato families.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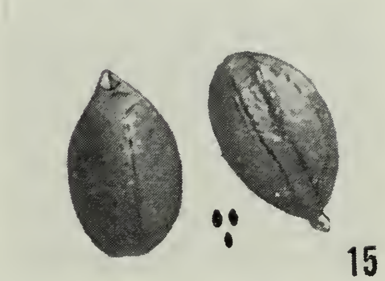
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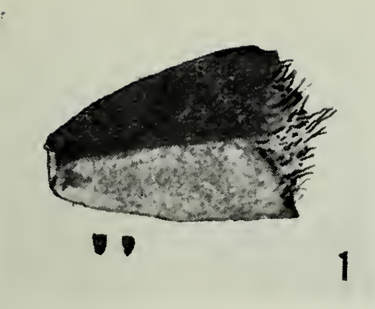
PLATE 22

1. MOTHERWORT, *Leonurus cardiaca* L. Dark brown; triagular in cross-section; hairy at top.
2. CATNIP, *Nepeta cataria* L. Dark reddish-brown; two white spots near lower end.
3. JIMSONWEED, thorn apple, *Datura* spp. Black; coarsely wrinkled and finely pitted.
4. BLACK HENBANE, *Hyoscyamus niger* L. Light gray and coarsely pitted.
5. COMMON MULLEIN, *Verbascum thapsus* L. Dark gray to brown; rows of small projections lengthwise.
6. MOTH MULLEIN, *Verbascum blattaria* L. Dark brown; surface rough.
7. TOAD-FLAX, butter and eggs, *Linaria vulgaris* Hill. Black; lens-shaped with a very broad wing around the seed and roughened by black tubercles.
8. COMMON PLANTAIN, *Plantago major* L. Greenish-brown to almost black; variable in shape and size. Distinct scar with net work of fine wavy lines.
9. RUGEL'S PLANTAIN, *Plantago rugelii* Dcne. Black; similar in shape to common plantain but slightly larger; surface rough but not lined.
10. RIBGRASS, *Plantago lanceolata* L. Glossy dark-brown; boat-shaped with deep grove and conspicuous scar in groove.
11. TEASEL, *Dipsacus sylvestris* Huds. Light-brown; 4-sided, each side with a ridge running down the middle.
12. MARSH ELDER, poverty weed, false ragweed, *Iva xanthifolia* Nutt. Dark gray to black with fine lines and mottled; often covered with membranous coating.
13. COMMON RAGWEED, *Ambrosia artemisiifolia* L. Seed-covering gray to brown; number of spines variable; seed, pear shaped and greenish-brown.
14. GREAT RAGWEED, *Ambrosia trifida* L. Gray to brown; much larger than the common ragweed.
15. COCKLEBUR, *Xanthium* spp. Brownish; spines stiff and hooked.



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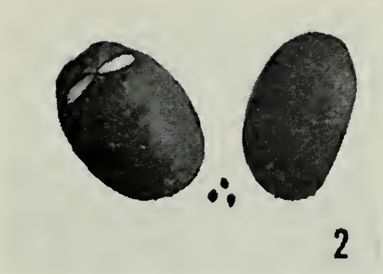

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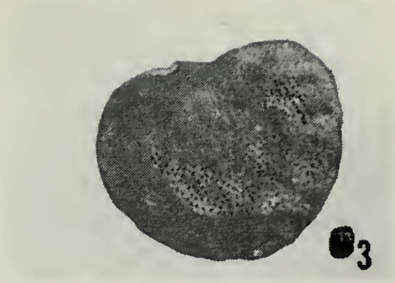

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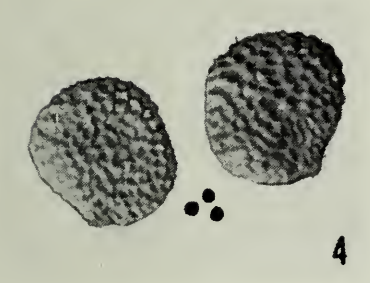

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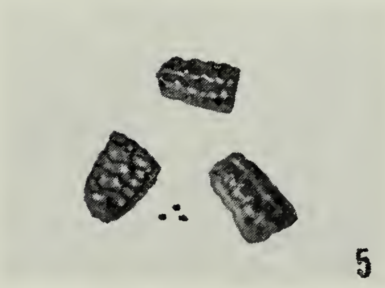
Figwort,
Plantain,
Teasel families.



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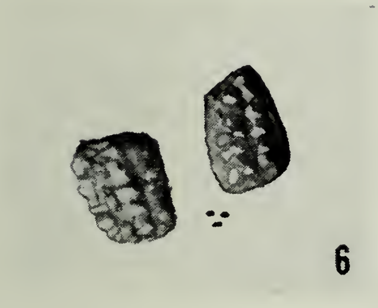

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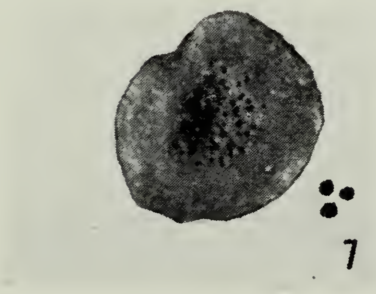

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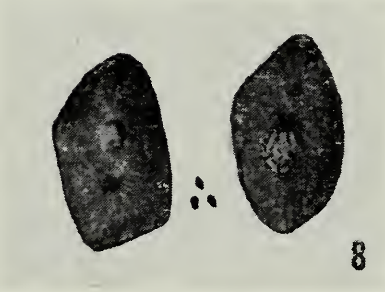

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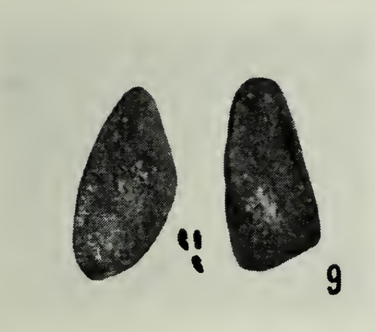

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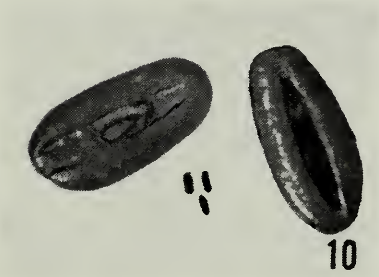

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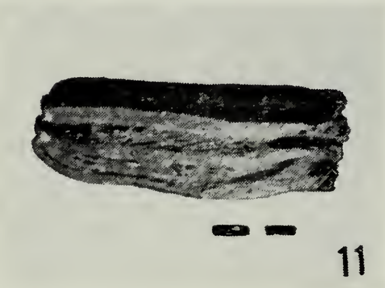

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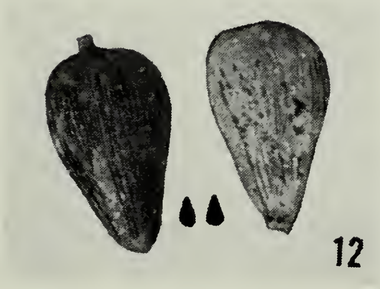
Composite family.



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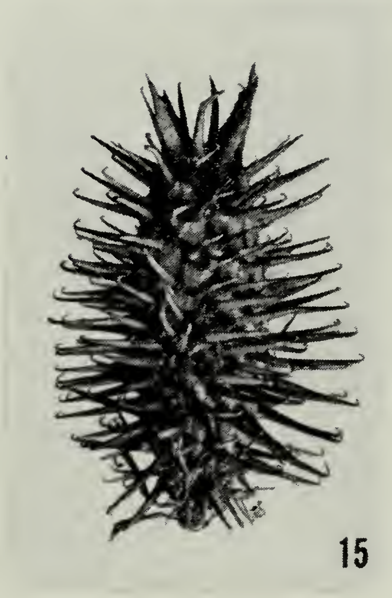

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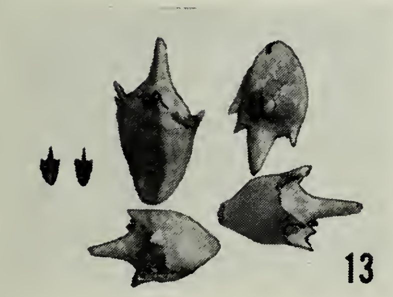

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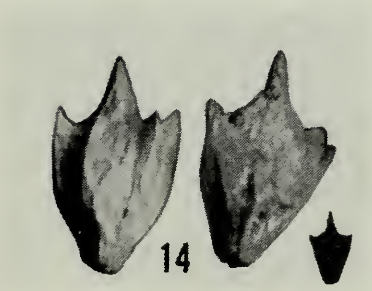

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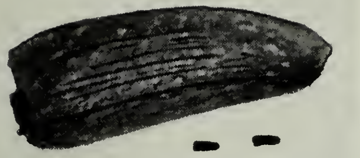
PLATE 23

1. Black-eyed susan, Cone-flower, *Rudbeckia* spp. Black; 4-angled with fine longitudinal lines.
2. Beggar's-ticks, pitch forks, *Bidens* spp. Brownish and flat.
3. Canada fleabane, *Erigeron canadensis* L. Yellowish.
4. Stinking mayweed, *Anthemis cotula* L. Grayish to brownish; surface roughened by small tubercles in longitudinal rows.
5. Pineapple weed, *Matricaria matricarioides* (Less.) Porter. Light gray with brownish lines.
6. Ox-eye daisy, *Chrysanthemum leucanthemum* L. var. *pinnatifidum* Lecoq. & Lamotte. Black with white ridges; knob-like projection at top of seed.
7. Tansy, *Tanacetum vulgare* L. Grayish; 5-ribbed.
8. Yarrow, *Achillea millefolium* L. Gray with white margin; flattened.
9. Common groundsel, *Senecio vulgaris* L. Grayish to brown or black; surface finely ridged lengthwise and covered with fine white hairs.
10. Burdock, *Arctium minus* Bernh. Brown; mottled with irregular ridges.
11. Nodding thistle, *Carduus nutans* L. Shiny, light brown with faint, darker, dotted lines.
12. Bull thistle, *Circium lanceolatum* Hill. Grayish-brown with faint, darker lines giving a slightly mottled appearance.
13. Canada thistle, *Circium arvense* (L.) Scop. Light brown or gray, faintly lined.
14. Scotch thistle, *Onopordum acanthium* L. Dark gray with irregular transverse ridges.
15. Knapweed, *Centaurea* spp. Shiny gray with faint lines.
16. Russian knapweed, *Centaurea repens* L. Light gray; faintly longitudinally ridged.
17. Chicory, *Cichorium intybus* L. Light to dark brown; somewhat angled and faintly ridged; fringe of short chaffy bristles around top.
18. Fall dandelion, *Leontodon autumnalis* L. Brownish with longitudinal and transverse ridges; no beak.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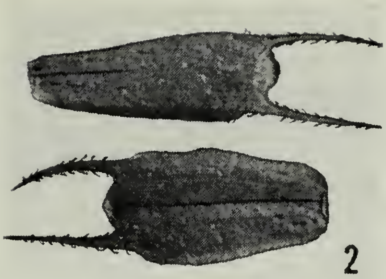
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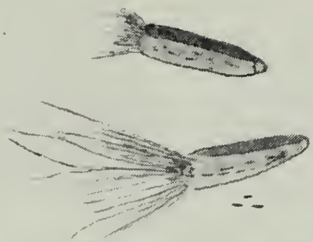
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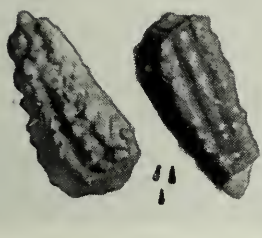
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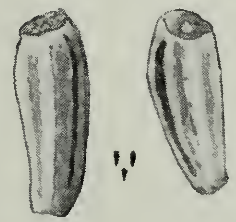
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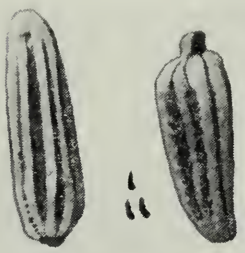
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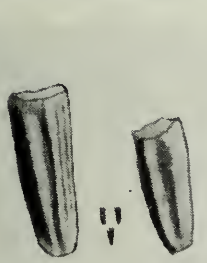
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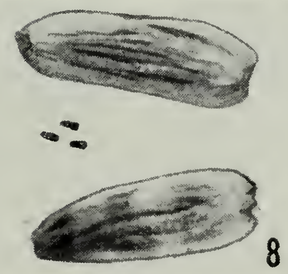
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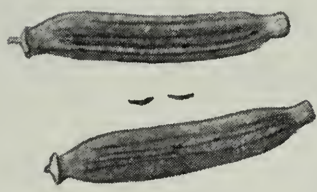
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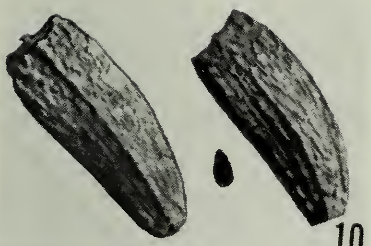
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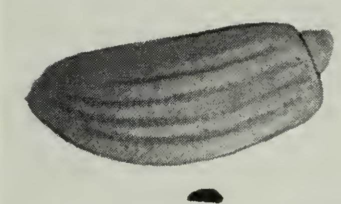
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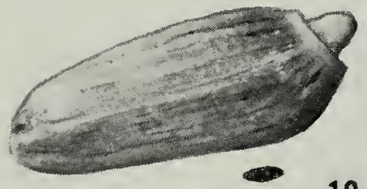
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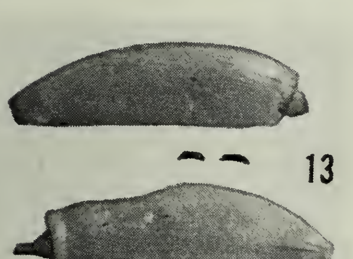
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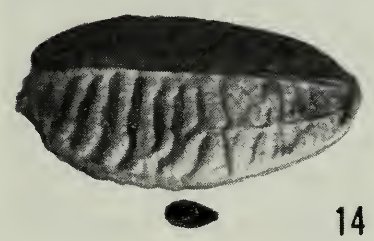
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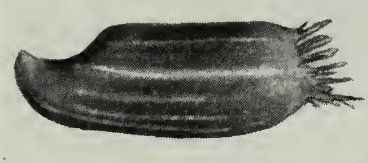
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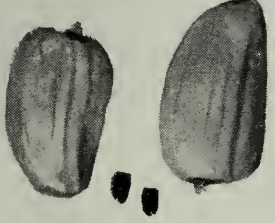
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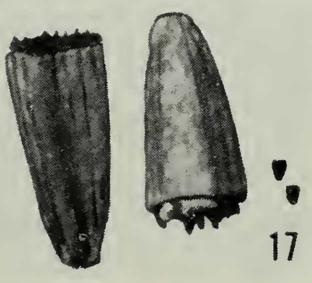
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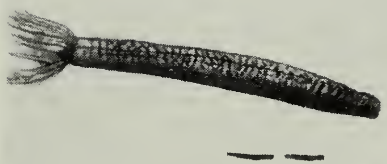
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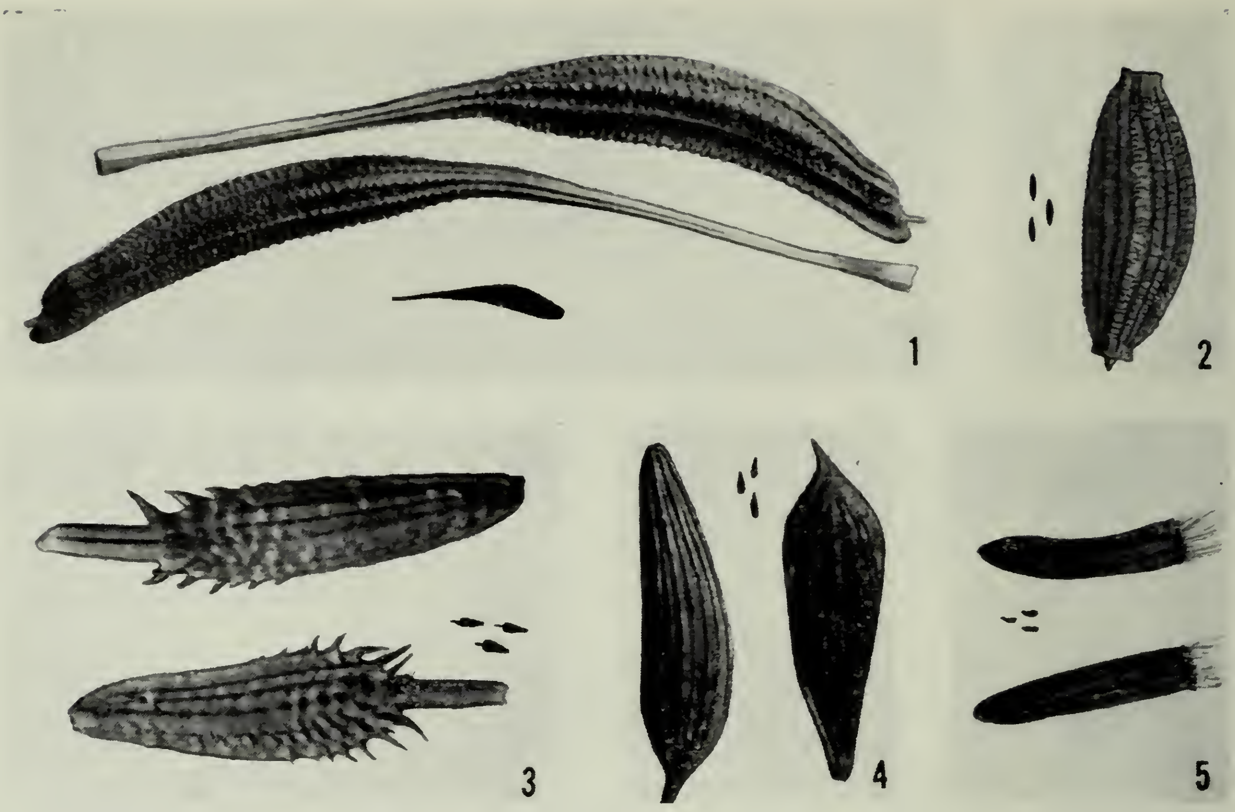

PLATE 24

1. Goat's-beard, *Tragopogon pratensis* L. Gray to brown with longitudinal, roughened ridges.
2. Perennial sow thistle, *Sonchus arvensis* L. Reddish brown, longitudinal ridges heavy with numerous cross wrinkles.

   Common annual sow thistle, longitudinal ridges less distinct, cross wrinkles on the whole surface.

   Spiny annual sow thistle. Seed flattened; three distinct longitudinal ridges, smooth, no cross wrinkles.
3. Common dandelion, *Taraxacum officinale* Weber. Brown; longitudinally ridged; ridges have spines on upper end of seed.
4. Prickly lettuce, *Lactuca scariola* L. Gray to brown; 5 to 7 longitudinal ridges on each surface and ridges faintly cross-wrinkled.
5. Orange hawkweed, *Hieracium aurantiacum* L. Black and strongly ribbed.

INDEX

Page
Abutilon theophrasti 45
Achillea millefolium 67
Agropyron repens 7
Agrostemma githago 21
Alder buckthorn 41
Amaranth, green 18
Amaranthus albus 19
Amaranthus graecizans 19
Amaranthus hybridus 18
Amaranthus retroflexus 18
Ambrosia artemisiifolia 64
Ambrosia trifida 66
Anthemis cotula 69
Arctium lappa 73
Arctium minus 71
Asclepias incarnata 49
Asclepias syriaca 49
Asclepias tuberosa 50
Aster spp. 63
Atriplex patula 17
Avena fatua 9
Ball mustard 29
Barbarea vulgaris 32
Barberry, common 25
Barberry, European 25
Barberry, Japanese 26
Barley, wild 7
Barnyard-grass 9
Bedstraw, yellow 61
Bedstraw, white hedge 61
Berberis thunbergii 26
Berberis vulgaris 25
Bindweed, black 15
Bindweed, field 50
Bindweed, hedge 50
Bitter dock 14
Bird vetch 35
Black bindweed 15
Black-eyed Susan 67
Black knapweed 75
Black medick 35
Bladder-campion 21
Blue-weed 52
Bouncing-bet 21
Brassica juncea 29
Brassica kaber 29
Broad-leaved dock 14
Broad-leaved plantain 61
Broad-leaved spurge 40
Buckhorn 61
Buckthorn, alder 41

Page
Buckthorn, common 41
Buckwheat, wild 15
Burdock, common 71
Burdock, great 73
Bull thistle 74
Butter-and-eggs 58
Buttercup, creeping 24
Buttercup, tall 24
Butterfly-weed 50
Camelina microcarpa 29
Camelina sativa 29
Campion, bladder 21
Canada fleabane 63
Canada thistle 73
Capsella bursa-pastoris 27
Carduus acanthoides 74
Carduus nutans 74
Carrot, wild 47
Catchfly, night-flowering 21
Catnip 54
Cenchrus longispinus 11
Centaurea jacea 75
Centaurea maculosa 75
Centaurea nigra 75
Cerastium arvense 21
Cerastium vulgatum 21
Charlock 29
Cheeses 42
Chenopodium spp. 16
Chenopodium glaucum 16
Chickweed, common 20
Chickweed, field 21
Chickweed, mouse-ear 21
Chicory 75
Chrysanthemum leucanthemum 69
Cichorium intybus 75
Cicuta maculata 46
Cinquefoil, rough 34
Cinquefoil, rough-fruited 34
Cinquefoil, silvery 34
Cirsium arvense 73
Cirsium lanceolatum 74
Cockle, purple 21
Cockle, sticky 21
Cockle, white 21
Common annual sow-thistle 79
Common barberry 25
Common burdock 71
Common buckthorn 41
Common chickweed 20
Common milkweed 49

PAGE
Common mullein 58
Common peppergrass 27
Common purslane 19
Common ragweed 64
Common tansy 70
Coneflower 67
Convolvulus arvensis 50
Convolvulus sepium 50
Couch-grass 7
Cowbane, spotted 46
Crabgrass, hairy 9
Crabgrass, smooth 9
Crataegus spp. 33
Creeping buttercup 24
Creeping Charlie 55
Cress, winter 32
Curled dock 14
Cuscuta spp. 50
Cynoglossum officinale 52
Cyperus esculentus 12
Cypress spurge 37
Daisy fleabane 64
Daisy, ox-eye 69
Dandelion 78
Dandelion, fall 78
Daucus carota 47
Descurainia sophia 32
Devil's paint-brush 81
Devil, king 81
Digitaria ischaemum 9
Digitaria sanguinalis 9
Dipsacus sylvestris 62
Dock, bitter 14
Dock, broad-leaved 14
Dock, curled 14
Dock, sour 14
Dodder 50
Dog fennel 69
Echinochloa crus-galli 9
Echium vulgare 52
Equisetum arvense 4
Erect knotweed 15
Erigeron annuus 64
Erigeron canadensis 63
Erigeron philadelphicus 64
Erigeron strigosus 64
Erysimum cheiranthoides 31
Erysimum hieracifolium 31
Euphorbia corollata 40
Euphorbia cyparissias 37
Euphorbia esula 40
Euphorbia helioscopia 40

PAGE
Euphorbia peplus 40
Euphorbia platyphylla 40
European barberry 25
Fall dandelion 78
False flax, large-seeded 29
False flax, small-seeded 29
Fennel, dog 69
Field bindweed 50
Field chickweed 21
Field horsetail 4
Field peppergrass 26
Finger-grass, hairy 9
Finger-grass, smooth 9
Fleabane, Canada 63
Fleabane, daisy 64
Fleabane, Philadelphia 64
Flixweed 32
Flower-of-an-hour 43
Flowering spurge 40
Fox-tail grass, green 10
Fox-tail grass, yellow 11
Galium spp. 61
Galium mollugo 61
Galium verum 61
Glecoma hederacea 55
Goat's-beard, yellow 77
Goldenrod 63
Goosefoot, oak-leaved 16
Grass, barnyard 9
Grass, couch 7
Grass, finger 9
Grass, green fox-tail 10
Grass, old witch 9
Grass, quack 7
Grass, rib 61
Grass, sour 14
Grass, squirrel-tail 7
Grass, tumble 9
Grass, twitch 7
Grass, smooth finger 9
Grass, yellow fox-tail 11
Great burdock 73
Great ragweed 66
Green amaranth 18
Green fox-tail grass 10
Ground ivy 55
Hairy crabgrass 9
Hairy vetch 35
Hawkweed, orange 81
Hawkweed, yellow 81
Hawthorn 33
Hedge-bedstraw, white 61

INDEX (*Continued*)

PAGE
Hedge bindweed 50
Hedge mustard 30
Hemlock, water 46
Hibiscus trionum 43
Hieracium aurantiacum 81
Hieracium spp. 81
Hordeum jubatum 7
Horse nettle 56
Horsetail, field 4
Horseweed 63
Hound's tongue 52
Hypericum perforatum 45
Indian mustard 29
Ivy, poison 40
Ivy, ground 55
Japanese barberry 26
King devil 81
Knapweed, black 75
Knapweeds 75
Knotweed, erect 15
Knotweed, prostrate 15
Knotweed, spotted 15
Lactuca scariola 80
Lady's thumb 15
Lamb's-quarters 16
Large-seeded false flax 29
Leafy spurge 40
Leontodon autumnalis 78
Lepidium campestre 26
Lepidium densiflorum 27
Lettuce, prickly 80
Linaria vulgaris 58
Lychnis alba 21
Mallow, musk 42
Mallow, round-leaved 42
Malva moschata 42
Malva neglecta 42
Malva rotundifolia 42
Matricaria matricarioides 69
Mayweed, stinking 69
Medicago lupulina 35
Medick, black 35
Milfoil 67
Milkweed, common 49
Milkweed, orange 50
Milkweed, swamp 49
Moth mullein 58
Mouse-ear chickweed 21
Mullein, common 58
Mullein, moth 58
Musk mallow 42
Mustard, ball 29

PAGE
Mustard, hedge 30
Mustard, indian 29
Mustard, tumbling 30
Mustard, wild 29
Mustard, wormseed 31
Narrow-leaved vetch 36
Narow-leaved plantain 61
Nepeta cataria 54
Neslia paniculata 29
Nettle, horse 56
Night-flowering catchfly 21
Nodding thistle 74
Nut-grass, yellow 12
Oak-leaved goosefoot 16
Old witch-grass 9
Onopordum acanthium 74
Orange hawkweed 81
Orange milkweed 50
Orache, spreading 17
Ox-eye daisy 69
Oyster plant 77
Paint-brush, devil's 81
Panicum capillare 9
Parsnip, water 47
Parsnip, wild 47
Pastinaca sativa 47
Pennycress 26
Peppergrass, field 26
Peppergrass, common 27
Perennial sow thistle 78
Petty spurge 40
Philadelphia fleabane 64
Pigweed, prostrate 19
Pigweed, redroot 18
Pineapple-weed 69
Plantago lanceolata 61
Plantago major 61
Plantago rugelii 61
Plantain, broad-leaved 61
Plantain, narrow-leaved 61
Plantain, purple-stemmed 61
Plantain, Rugel's 61
Poison ivy 40
Polygonum achoreum 15
Polygonum aviculare 15
Polygonum convolvulus 15
Polygonum erectum 15
Polygonum persicaria 15
Prostrate knotweed 15
Prostrate pigweed 19
Portulaca oleracea 19
Potentilla argentea 34

PAGE
Potentilla intermedia 34
Potentilla norvegica 34
Potentilla recta 34
Prickly lettuce 80
Purple cockle 21
Purple-stemmed plantain 61
Purse, shepherd's 27
Purslane, common 19
Pusley 19
Quack-grass 7
Queen Anne's lace 47
Ragweed, common 64
Ragweed, great 66
Ranunculus acris 24
Ranunculus repens 24
Redroot pigweed 18
Rhamnus cathartica 41
Rhamnus frangula 41
Rhus radicans 40
Rib-grass 61
Rocket, yellow 32
Roman wormwood 64
Rough cinquefoil 34
Rough-fruited cinquefoil 34
Round-leaved mallow 42
Rudbeckia serotina 67
Rugel's plantain 61
Rumex acetosella 14
Rumex crispus 14
Rumex obtusifolius 14
Rush, scouring 4
Russian thistle 17
Salsify 77
Salsola kali 17
Saltwort 17
Sandbur 11
Saponaria officinalis 21
Scotch thistle 74
Scouring-rush 4
Setaria glauca 11
Setaria viridis 10
Sheep sorrel 14
Shepherd's purse 27
Silene noctiflora 21
Silene cucubalus 21
Silvery cinquefoil 34
Sisymbrium altissimum 30
Sisymbrium officinale 30
Sium suave 47
Small-seeded false flax 29
Smooth crabgrass 9
Smooth finger-grass 9

PAGE
Soapwort 21
Solanum carolinense 56
Solidago spp. 63
Sonchus arvensis 78
Sonchus asper 79
Sonchus oleraceus 79
Sorrel, sheep 14
Sour dock 14
Sourgrass 14
Sow-thistle, common annual 79
Sow-thistle, spiny annual 79
Sow-thistle, perennial 78
Spiny annual sow thistle 79
Spotted cowbane 46
Spotted knotweed 15
Spreading orache 17
Spurge, broad-leaved 40
Spurge, Cypress 37
Spurge, flowering 40
Spurge, leafy 40
Spurge, petty 40
Spurge, sun 40
Squirrel-tail grass 7
St. John's-wort 45
Stellaria media 20
Sticky cockle 21
Stinking mayweed 69
Stinkweed 26
Sun spurge 40
Susan, black-eyed 67
Swamp milkweed 49
Tall buttercup 24
Tanacetum vulgare 70
Tansy, common 70
Taraxacum officinale 78
Tare 35
Tare, wild 36
Teasel 62
Thistle, bull 74
Thistle, Canada 73
Thistle, nodding 74
Thistle, Russian 17
Thistle, Scotch 74
Thistle, welted 74
Thlaspi arvense 26
Thorn-apple 33
Toadflax 58
Tragopogon dubius 77
Tragopogon porrifolius 77
Tragopogon pratensis 77
Trefoil, yellow 35
Tufted vetch 35

INDEX (*Continued*)

	PAGE
Tumbling mustard	30
Tumble-grass	9
Tumbleweed	19
Twitch-grass	7
Velvet-leaf	45
Verbascum blattaria	58
Verbascum thapsus	58
Vetch, bird	35
Vetch, hairy	35
Vetch, narrow-leaved	36
Vetch, tufted	35
Vicia angustifolia	36
Vicia cracca	35
Vicia villosa	35
Water hemlock	46
Water parsnip	47
Welted thistle	74
White cockle	21
White hedge bedstraw	61

	PAGE
Wild barley	7
Wild buckwheat	15
Wild carrot	47
Wild mustard	29
Wild oats	9
Wild parsnip	47
Wild tare	36
Winter-cress	32
Witch-grass, old	9
Wormseed mustard	31
Wormwood, Roman	64
Yarow	67
Yellow bedstraw	61
Yellow fox-tail grass	11
Yellow goat's-beard	77
Yellow hawkweed	81
Yellow nut-grass	12
Yellow rocket	32
Yellow trefoil	35

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HORSES

ONTARIO DEPARTMENT OF AGRICULTURE

PARLIAMENT BUILDINGS, TORONTO, CANADA

CONTENTS

PAGE

1. Introduction

(a) The Prehistoric Horse 1
(b) Horses in Ontario 1
(c) Horses in Ceremonials 1
(d) Horses at the Royal Winter Fair 1
(e) Horses on the Race Track 2
(f) Horses in Law Enforcement 2
(g) The Future of the Horse 2

2. Types and Breeds of Horses

(a) Considerations in Classifying Horses 3
(b) Types of Horses 3
(c) Characteristics of Draft Horses 4
(d) Breeds of Draft Horses 5
(e) Saddle Type Horses 7
(f) Light Harness or Roadster Type 11
(g) Heavy Harness or Carriage Type 14
(h) Ponies 14

3. Feeds, Feeding and Management

(a) General Considerations in Feeding Horses 15
(b) Feeds 16
(c) Preparation of Feeds 17
(d) Rations for Horses 17
(e) Conditioning the Horse 18
(f) Grooming 19
(g) The Care and Feeding of the Stallion 20
(h) Feeding and Management of the Brood Mare 20
(i) Care of the Foal 22

4. Considerations in Selecting Horses and Stallions

(a) Common Unsoundnesses 27
(b) How to Determine a Horse's Age 33
(c) The Stallions Act 36

5. Definition of Common Terms 37

6. Colours and Markings of Horses

(a) Description of the Various Colours 38
(b) Description of Colour Markings on the Limbs 39
(c) Description of Colour Marking on the Head 39

7. Gait Terminology 41

8. Defects and Peculiarities in Way of Going 43

9. Equitation

(a) The Use of the Bit 45
(b) Learning to Ride 46
(c) Mounting and Dismounting 46
(d) Position in the Saddle 48
(e) The Use of Aids 49
(f) Disobedience 49
(g) Driving Heavy Harness Horses 50

10. Housing and Equipment 51

HORSES

This bulletin has been prepared by a Committee consisting of staff members of the Animal Husbandry Department, Ontario Agricultural College and the Live Stock Branch, Ontario Department of Agriculture. The writers wish to express their appreciation to officers of Breed Associations and successful breeders who co-operated by furnishing information.

FOREWORD

Although the horse population of Ontario has declined sharply in the past quarter century, members of the equine species still occupy an important place in the daily pursuits of a great many farmers and sportsmen. Despite this downward trend, there are reasons for believing that horse power, in its original form, will be required on Ontario's small farms for many years to come. Furthermore, the popularity of horses as feature attractions at major shows and race tracks is likely to increase rather than abate.

As long as people continue to raise and maintain horses there will be a demand for information with respect to the finer points of horse husbandry. With fewer people keeping horses, reliable sources of practical information have greatly diminished. Consequently, this bulletin has been prepared in the hope that it will be of assistance to those who wish to improve their knowledge of this class of live stock, which has contributed so much to the development of this country.

INTRODUCTION

1. The Prehistoric Horse

Scientific discoveries of comparatively recent times point to the conclusion that the progenitors of the modern horse inhabited this earth three million years ago. Fossil remains have been unearthed in North and South America, Europe, Asia and Africa which indicate that the original horse was probably less than nine inches in height, had four toes on each front and three on each hind foot.

The evolution of the horse from prehistoric to modern times covers twelve geological periods; each effected a change in the size, conformation and appearance of the animal. It is generally believed that the original horses were hunted for food. As they emerged from the swamps to solid land and increased in size they were driven by man. Later when the metamorphosis became more complete they were ridden and used as beasts of burden.

2. Horses in Ontario

According to census figures, there were 578,157 horses in Ontario in 1931. This population changed very little in the next nine years. However, when farm help became difficult to obtain following the outbreak of World War II, farmers were obliged to resort to mechanical power. The purchase of farm tractors increased very greatly; the extent of this upward surge in the use of mechanical power was not fully appreciated until the results of the 1951 census revealed that the horse population had declined to 260,627.

Despite this reduction, horses are still used to supply the power on a great many Ontario farms. The operators of many large farms admit that horses can do certain jobs more effectively and at a lower cost than tractors, while the owners of small farms have discovered that it is more economical to hire custom operators than to own a tractor and all the equipment that necessarily must complement it.

3. Horses in Ceremonials

Those who viewed the procession, which comprised part of the coronation ceremonies, on TV sets or in the theatre must have been amazed to see Queen Elizabeth II riding to and from Westminster Abbey in a horse-drawn vehicle, in this age of modern transportation. They also must have been thrilled at the sight of the members of the R.C.M.P. mounted on their fine steeds. This colorful force provided a fitting symbol of Canada at the heart of the Commonwealth of Nations. As the seemingly endless procession moved to its destination even those who had begun to think of the horse as a creature of by-gone ages must have had cause to alter their views as the many fine specimens of horse flesh displayed well-nigh human intelligence in maintaining their formations in the midst of all the diversions and excitement.

4. Horses at the Royal Winter Fair

Later in 1953, thousands packed the amphitheatre of the Royal Winter Fair, a truly national show which enjoys Royal patronage, to witness horses in action, including the outstanding performance of the "Mounties". When it was rumoured that this famous troop might be disbanded at the conclusion of the show, loud protestations were received from all parts of Canada. Many Canadians believe that it should be sent on more foreign assignments as a means of promoting the good name of our fair Dominion in other parts of the world.

Although the performance classes at the Royal Winter Fair attract the greatest number of people, they do not constitute the only horse classes at this great show. Competition is provided for breeding animals and utility classes are featured, thus bringing together some of the best stallions and mares of the various breeds, and many of the outstanding geldings which are shown on the line, in teams, and in multiple hitches. These competitions have been important factors in fostering the production of better horses in Canada.

5. Horses on the Race Track

Canada's outstanding sporting event for Thoroughbreds is the Queen's Plate, the oldest fixture run continuously on this continent. This famous race is for three-year-olds, which are the property of British subjects resident in Canada and which have not started in a race as three-year-olds, the "Plate" trial excepted. The distance is one mile and one furlong; the prize is fifty guineas, the gift of Her Majesty the Queen, with an additional guaranteed amount consisting of stakes and added money. The 95th running of this race was staged in 1954, at the Woodbine Park in Toronto.

The Hambletonian stake, which is run annually at Goshen, New York, is generally considered to be America's outstanding race for harness horses. In 1953, a Canadian-owned filly named Helicopter was the winner of this famous classic. Although this filly was bred in United States, most breeders and lovers of Standard Bred horses experienced a feeling of pride upon learning that a recent import had achieved a feat which had never been accomplished previously by a Canadian-owned horse.

6. Horses in Law Enforcement

In this age of speed, police departments are equipped to deal promptly in matters respecting law enforcement. Radio is used to alert officers located over a wide area of the whereabouts of a suspected criminal; high powered cars carry those in the best position to cope with the situation to his hideout. Even so, horses are still used by most metropolitan police forces. They perform their most useful services on ceremonial occasions, particularly when it becomes necessary to restrain crowds from impeding the progress of processions. No mechanical device has proven as effective in carrying out these assignments as a mounted policeman.

7. The Future of the Horse

There is little likelihood of horses being as numerous during the second half of the twentieth century as they were in the first half. On the other hand it would be utter recklessness to predict that horses will disappear. In view of the role which they play in providing power on the farm and in furnishing pleasure and entertainment to sportsmen, it is reasonable to assume that there will be a market for good horses of particular types in the foreseeable future. However, it is equally apparent that the horses which will command attractive prices must be capable of performing in a satisfactory manner, whether it be on the farm, in the show ring or on the race track.

TYPES AND BREEDS OF HORSES

1. Considerations in Classifying Horses

The following points must be considered in classifying horses:—

(a) Height—Height is measured at the highest point of the withers and is stated in hands and inches. A hand is four inches; fractions of hands are expressed in inches. Hence, a horse measuring 62 inches is 15-2 hands in height. Ponies must not exceed 14-2 hands.

(b) Weight—Horses of draft type are usually classified into heavy or light drafts. At some shows, horses weighing less than 1500 pounds are classified as light drafts, at other shows the dividing point is 1600 pounds, while at the Royal Winter Fair horses weighing up to 1700 pounds still qualify for the light draft class.

(c) Form—This term refers to the general outline of the horse. Usually, form is described by adjectives such as smoothly-turned or angular, massive or lithe, or low set or rangy.

(d) Substance—This term refers to the development of body and bone and should not be confused with size. A small horse will have substance provided it is well balanced, has plenty of depth and thickness of body and ample bone development in relationship to its size.

(e) Quality—This term refers to the degree of excellence, and is usually used along with a qualifying adjective to describe the hide, hair, bone and general conformation.

(f) Condition—When applied to draft breeds, condition invariably refers to the amount of fat that the horse is carrying. In the case of a race horse, it refers to the degree of training or conditioning which he has received.

(g) Temperament—Temperament refers to disposition; horses of the light breeds have highly developed nervous systems, hence are more temperamental than horses of the heavy breeds.

(h) Manners—The term "manners" refers to the behaviour of the horse. Being acquired characteristics, they are influenced to a great extent by training. In many cases the value of a horse depends upon what he can do and how well he can do it.

(i) Colour—This term is self-explanatory. Although no good horse is a bad colour, the value of a horse is often enhanced by an attractive colour. Since bays, browns, chestnuts, grays and blacks can usually be matched into teams, fours or sixes quite readily, they are the most popular colours. The first three colours are fairly stable, hence change less with age and season. Odd coloured horses may be desirable for showing in certain classes.

2. Types of Horses

The species commonly referred to as the horse, embraces a variety of types with each being specially adapted to perform a particular function. It also comprises a variety of sizes, ranging from the small models, exemplified by Shetland Ponies, to the massive animals typified by the draft breeds. In general, the common types and the breeds included in each type are as follows:

(a) Draft or work type—Belgian, Clydesdale, Percheron, Shire, and Suffolk.

(b) Saddle type—Arabian, Thoroughbred, Canadian Hunter, American Saddle, Palomino, Appaloosa, Morgan, Quarter Horse, Tennessee Walking Horse, and Anglo-Arabian.

(c) Light Harness or Roadster Type—American Trotter or Standard Bred.

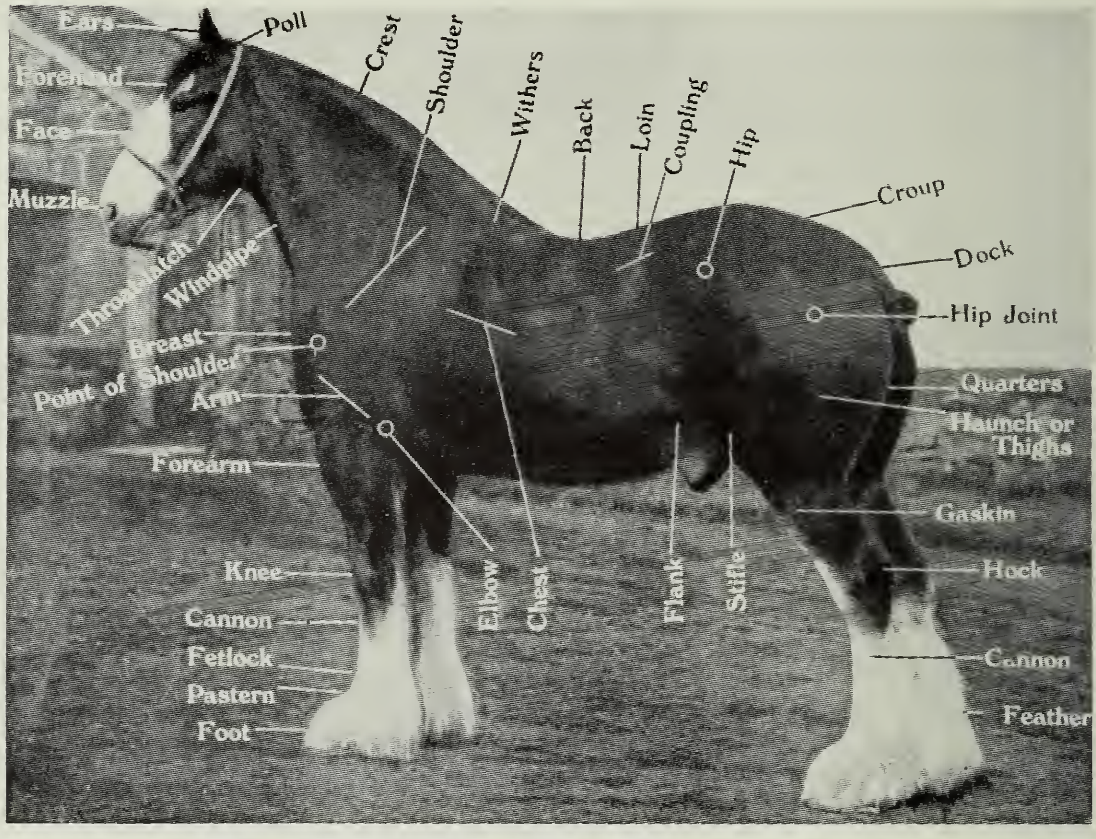
(d) Heavy Harness or Carriage Type—Hackney.

(e) Fine Harness Type—American Saddle Horse.

(f) Pony Type—

(1) 14.2 and under—Exmoor, Dartmoor, Hackney, Iceland, Polo and Welsh ponies.

(2) Not exceeding 11 hands in Canada and 11.2 hands in United States—Shetland ponies.



The names and location of the points of a draft horse.

3. Characteristics of Draft Horses

Each breed of draft horse has different characteristics with respect to colour, feathering on the legs and to a degree in body conformation. Nevertheless, all good draft horses, regardless of breed, have certain characteristics in common.

As a general rule, mature draft horses stand 16 to 17-2 hands in height, with those in the lower height range being in the light draft category, whereas the taller ones qualify for the heavy draft classes. However, weight rather than height is the deciding factor in separating horses of the draft breeds into these two classes.

Substance and quality are prime requisites in all good draft horses. Substance is exemplified by size and scale, and should not be confused with fat. For example, a horse in good working condition may weigh the same as a fat horse; however the former will have more substance because a lesser portion of his weight will be accounted for by fat. The hair, bones and joints should show evidence of quality. The best indications are hair that is fine and silky, bone that is smooth and attractive, and joints that are neatly turned. Frequently, coarse joints are associated with coarse bone and poor feet.

Although draft horses are not expected to perform their daily routine at high speeds, their action should be bold and true. Good "movers" pick up their feet in a snappy manner, carry them clear of the ground, and show the sole of the foot clearly while in motion. A free and easy knee and hock movement is essential to high class action. Furthermore, the draft horse should carry his head and shoulders high and in a stylish manner.

In recent years, classes for two, four and six horse teams have become popular at the major shows. Pairs of draft horses should be well matched, work together as a unit, and show evidence of strength and agility. These characteristics are equally important in four and six horse teams. When hitching these combinations, the heaviest team should be at the wheel and the lightest one in the lead.

4. Breeds of Draft Horses

(a) Belgians

As the name implies, this breed of horses originated in Belgium. Because of its importance to the early economy of that country, government funds were expended rather generously for the improvement of the breed.

Belgian horses were first imported into United States in 1866. In the years that followed, and particularly those of the 20th century, general quality of the breed improved very greatly. Several stallions made an outstanding contribution to this improvement, the most notable ones being Farceur, who was foaled in 1910 and died in 1921 and Jay Farceur, one of his descendants, who was eventually owned in Canada. In fact, most of the credit for the greatly improved quality of underpinning of the modern Belgian horse is given to Farceur.

The Canadian Belgian Horse Association was organized in 1907. Between that year and December 31st, 1953, 10,941 representatives of the breed were registered in Canada.

(b) Clydesdales

History records that John Paterson of Lanarkshire, Scotland, purchased a Flemish stallion in England between 1715 and 1720. This stallion, when mated to the native mares of the district, produced offspring which were brown or black in colour and which had white faces and some white on their legs. These horses became the progenitors of the breed that derived its name from the Clyde, a river which meanders through the county of Lanark.

Stallions of the Shire breed were used in the development of the Clydesdale up to 1860. Since then no outside blood has been directly introduced. However, the practice of "grading up" is still permitted, mares having four top pure bred sires being eligible for registration. Several stallions have played important roles in breed improvement, the most renowned ones being Darnley, Prince of Wales (1866-1888), Baron's Pride (1890-1913), Baron of Buchlyvie (1900-1914) and Dunure Footprint (1908-1930).

The first Clydesdale was imported into Canada in 1840. Forty-six years later, that is in 1886, the Clydesdale Horse Association of Canada was organized. Between that year and December 31st, 1953, 30,249 stallions and 64,461 mares were registered.

Clydesdale stallion. This horse has a high degree of breed character, draft type and quality and was one of the great breeding Clydesdale stallions in Canada.

(c) The Percheron

This breed, which was developed in La Perche district of France, was originally used for hauling stage coaches. During that period, two Arabian stallions, Godolphen and Gallipoli, were used to improve the breed from the standpoint of speed in travelling. Both stallions were gray in colour, so undoubtedly exerted an influence on the future colour of the breed.

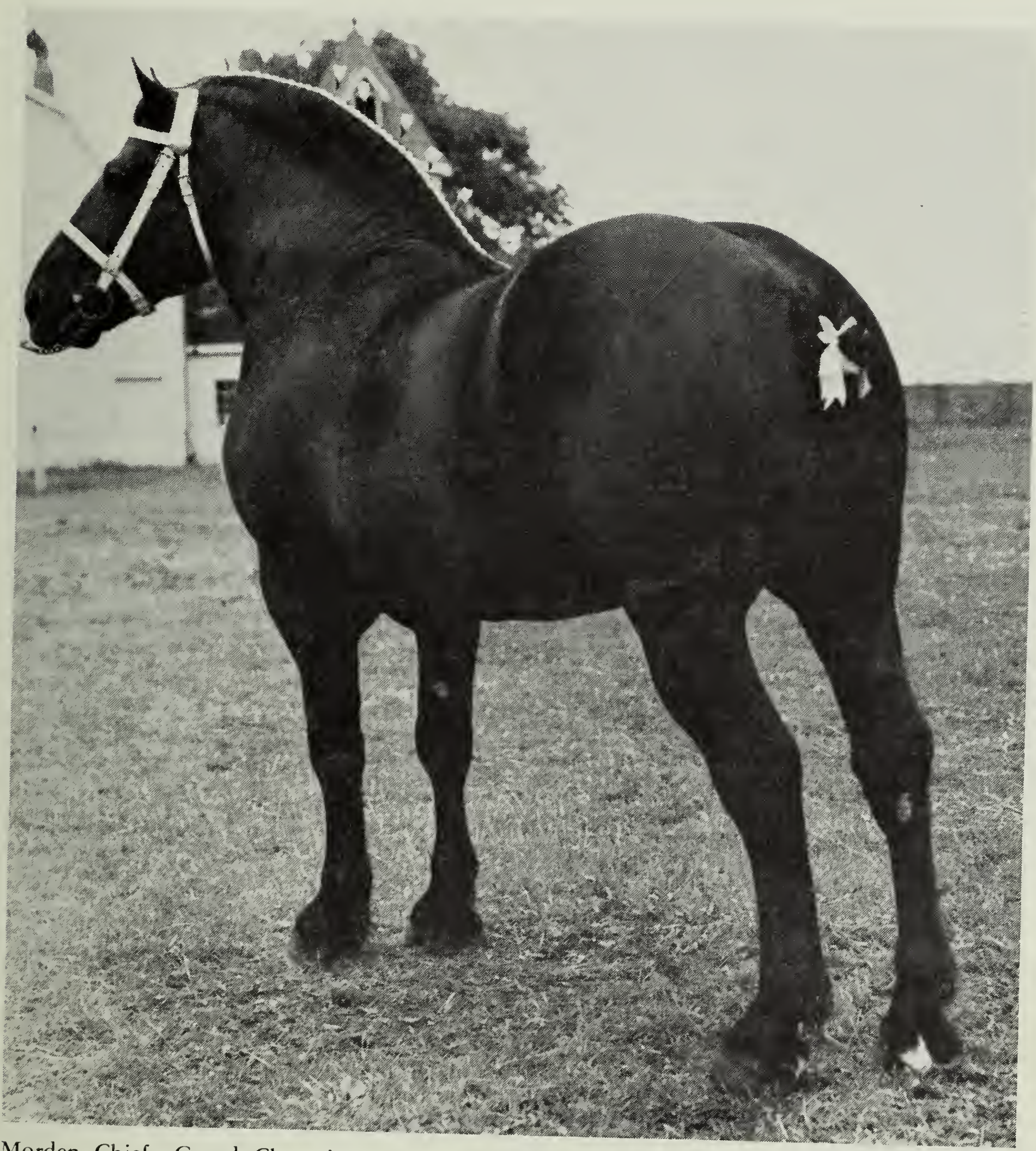
With the advent of railways, stage coaches became less popular as a means of travel. This caused breeders to alter their ideals with respect to type. Efforts were directed towards the production of thicker, blockier animals.

Percherons were first imported into United States in 1839 and were brought into Canada a few years later. Several stallions have influenced the type and conformation of the breed on this continent, notably Brilliant, foaled in 1877; Brilliant the Third, foaled in 1884; Carnot, foaled in 1905; and Laet, foaled in 1916. Carnot was often described as the stallion with almost faultless action.

The Canadian Percheron Association was organized in 1907. Registrations up to the end of 1953 totalled 19,298 stallions and 23,915 mares.

(d) Shires and Suffolks

These two breeds of English origin have never been very popular in this country. In 1953, there were no Shire horses and only three Suffolks registered in Canada.



Morden Chief—Grand Champion Percheron stallion at the 1952 Royal Winter Fair. This stallion weighed a little over 2,100 pounds when exhibited at the Royal. Note the correctness of the under-pinning together with breed character and substance.

5. Saddle Type Horses

(a) The Arabian

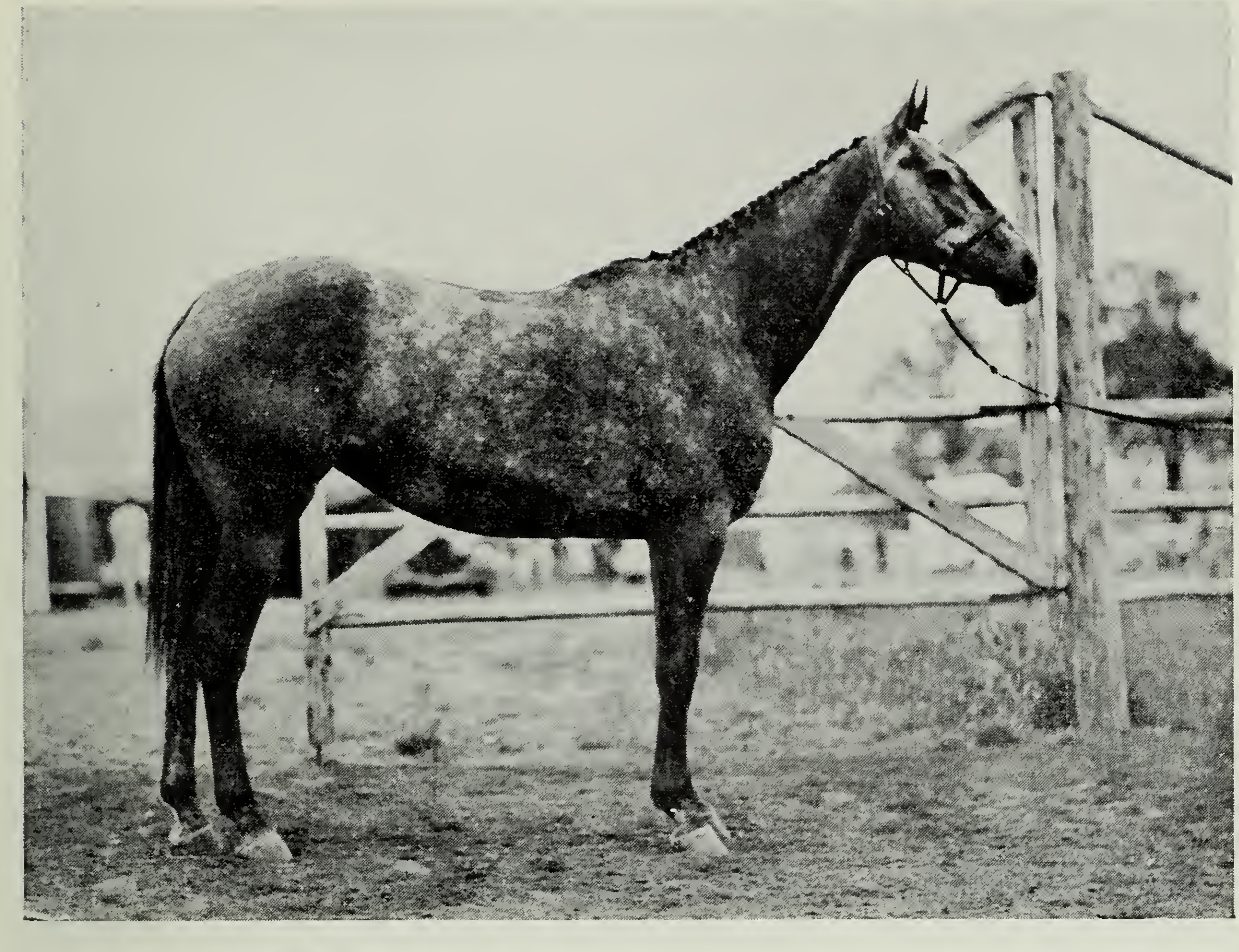
The Arabian horse was one of the first breeds of live stock to be developed by man. Although its history is obscured by myth and tradition, it is fairly obvious that efforts were directed towards producing a horse of saddle type that would be suitable for use in waging war. Inasmuch as horses of this breed possessed many desirable characteristics, they have been used quite extensively in establishing and improving breeds which came into existence centuries later. Stock imported by Charles II between 1660 and 1685 became the foundation for the early British horse.

Panatomic—Thoroughbred stallion Grand Champion at the Royal Winter Fair in 1949.

(b) The Thoroughbred

This breed traces its origin to Arab, Barb and Turk stallions imported into England about the close of the 17th century. They were mated to native mares for the purpose of producing horses for racing. In the years following, the breed has undergone many changes, the most notable one being an increase in height. Three stallions,—Eclipse, Herod and Matchem have exerted an outstanding influence on the development of the breed. As a general rule, modern Thoroughbreds range in height from 15 to 16 hands with a few being taller. The weight varies between 1,000 and 1,200 pounds and up.

The Canadian Thoroughbred Society was incorporated in 1906 for the purpose of promoting the breed. In 1953 it had a larger membership than any other Canadian horse breed society or association.



A good type of middle weight Hunter. A prize winner in both Canada and the United States.

(c) The Canadian Hunter

The Canadian Hunter, Saddle and Light Horse Improvement Society was organized in 1926 for the purpose of promoting the production of a type of horse suitable for hunting and jumping. Shortly thereafter farmers were encouraged to breed their heavy draft mares to Thoroughbred stallions. In 1933, a registry for hunters was established and at present animals of suitable type and conformation are eligible for registration, as well as those whose parents are registered.

In show rings, hunters are usually classified into 3 types:

(a) Light weight—up to carrying 165 pounds.

(b) Middle weight—up to carrying 185 pounds.

(c) Heavy weight—up to carrying over 185 pounds.

In addition to the difference in their ability to carry weight, hunters in these classes vary in size, substance and amount of bone.

A good hunter should have unusually long shoulders, which slope and extend into high wedge-shaped withers. With this type of shoulders and withers, riders are obliged to sit farther back on the horse. Since the centre of gravity is just behind the front legs there is less likelihood of the horse stumbling if the rider is behind that point.

The hind quarters of a good hunter are long and well muscled; the hocks are strong and free from coarseness, otherwise they will not stand up under the strain to which they are subjected when jumping.

Jumpers are judged mainly on their performance. The larger shows feature classes for "green" hunters, "working" hunters, "ladies' working" hunters and others, including knock down and out.

(d) Saddle Horse Types

There are two recognized saddle horse types,—the three-gaited and the five-gaited. In Canada, the former type is more popular than the latter, probably because less skill and patience are required in their training.

Three-gaited saddle horses are judged on conformation, manners and gaits. They should carry their weight balanced on all four legs; the head should be held moderately high, the neck should be arched and the face should be held at a 60° angle to the ground without undue pressure being exerted on the mouth.

The three gaits are the walk, the trot and the canter. The walk should be true, flat-footed, rapid and elastic; the trot square, balanced and free from Hackney form; the canter slow, smooth and straight with the greater part of the weight on the haunches. When cantering a horse should be able to lead with either fore leg.

Horses which are not of pure breeding may qualify for three-gaited classes. However a great many three-gaited horses have ancestors of American Saddle Horse breeding.

The American Saddle Horse, developed by plantation owners in United States, traces its origin to a Thoroughbred stallion named Denmark. Early breeders aimed at producing horses which were sure footed, had a kind disposition, possessed courage and ambition, had good conformation and a number of gaits.

Five-gaited horses must acquire a slow gait and a rack in addition to the walk, trot and canter. The slow gait resembles a running walk, while the rack, being fast and smooth, is similar to the gait of a pacer.

American saddle horses may qualify for combination classes. First they are hitched to a suitable four-wheeled vehicle and shown at the walk and trot; then unhitched and shown under the saddle. Usually fifty per cent of the points are allowed for each performance.

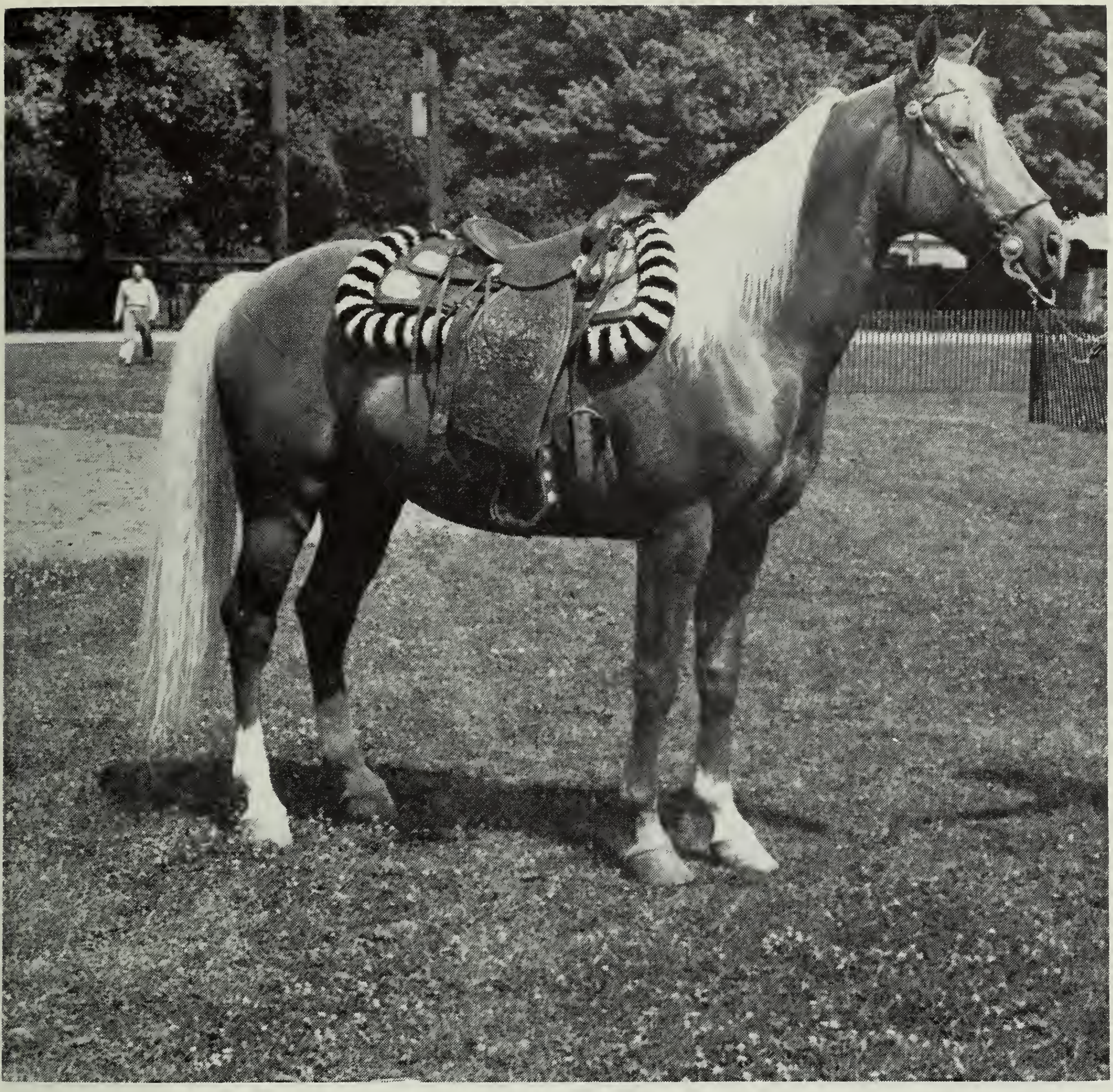
(e) The Palomino

This breed was developed in United States. Although its origin is somewhat obscure, it is believed that the original representatives of the breed were selected mainly on the basis of colour. However, as more animals possessing desirable colour markings were produced, standards for type and conformation were adopted.

At present, Palominos are judged on conformation, colour and manners,—with colour still being a major consideration. The ideal horse has a body which is golden in colour and a mane and tail which are silver, ivory or white. Light skins and wall eyes are disqualifications.

The height varies from 15 to 16.2 hands and the weight ranges from 900 to 1,200 pounds. Individuals must be free movers at the walk, trot and canter. They must also have a docile temperament, be sound in eye, wind and limb, and have an attractive appearance.

The Palomino Horse Association of Canada was organized in 1944, and a registry was established a few years later. In 1953, this Association was granted membership in the Canadian National Live Stock Records, and all recording is now done through that office.



A Palomino

(f) Other Saddle Type Horses

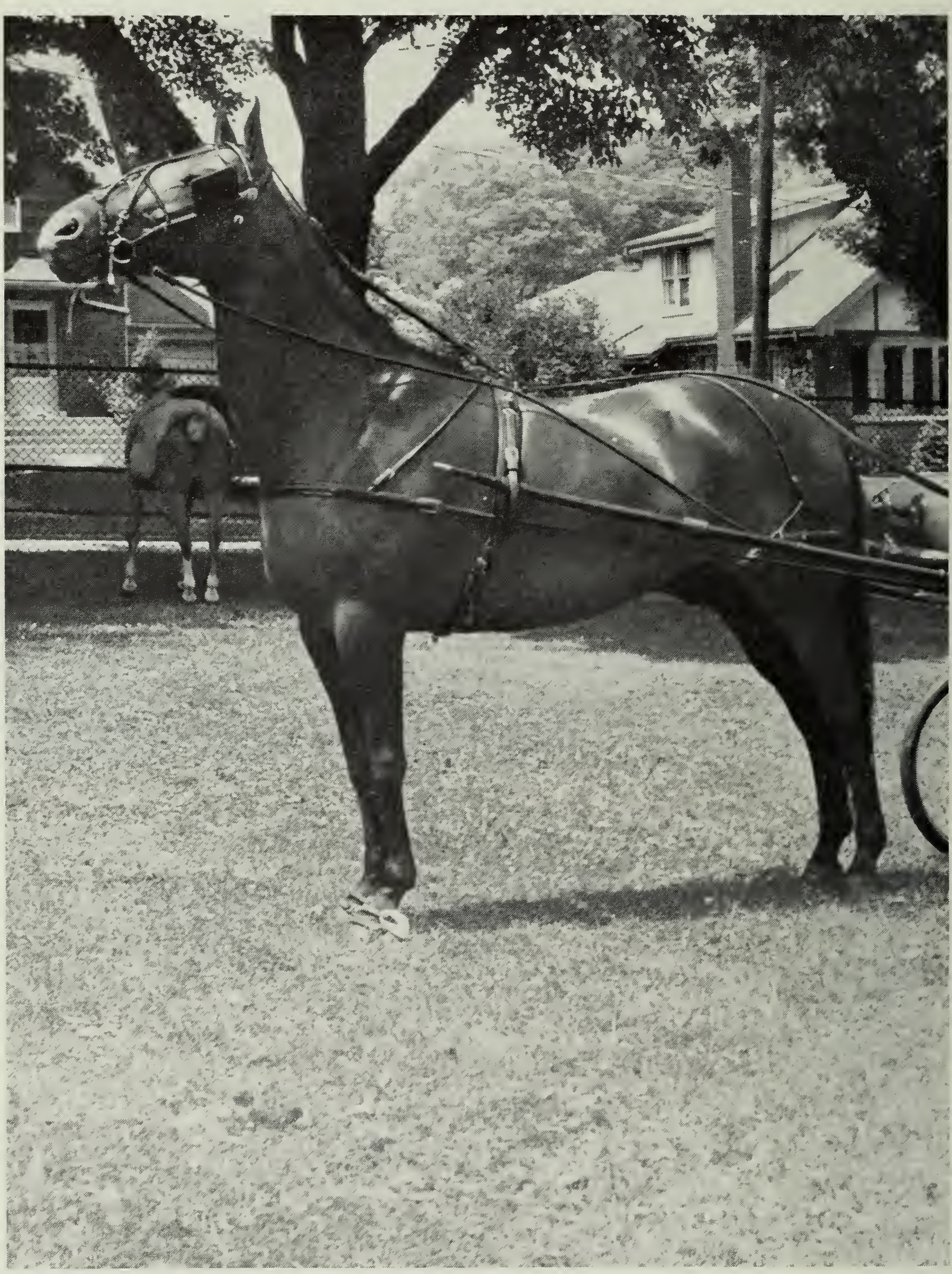
The Appaloosa, Morgan, Quarter Horse and Tennessee Walking Horse have never been popular in Canada. Occasionally a Tennessee Walking Horse performs at the Royal Winter Fair. However, representatives of the other breeds are seldom seen in Ontario. The Appaloosa and Quarter Horse were developed as cow ponies in United States and are experiencing a wave of popularity in the ranching areas of that country.

6. Light Harness or Roadster Type

(a) The Standardbred or American Trotter

This breed was developed in United States for driving purposes and later for harness racing. The foundation sire was Messenger, a grey Thoroughbred, imported from England in 1788. When mated to native mares, his offspring showed an aptitude to trot rather than run.

The stallion, Hambletonian 10, foaled in 1849, is credited with being the original breed improver. His real worth was not recognized until his son, Dexter, came into prominence by defeating all competition during the years 1864-67 inclusive. At one time Hambletonian stood at a service fee of $500.00 and during his lifetime left over 1,300 colts. Following his death, a monument was erected to his memory at Goshen, New York, a town that was destined to become the site for the Classic Stake Race which bears its name.



A Roadster

(b) The Roadster or Trotter

The ideal road horse is between 15 and 16 hands in height and weighs from 900 to 1,200 pounds. A desirable conformation includes a shapely body, sound feet and legs and an attractive and dignified appearance. The action should be free and easy, straight and well-balanced—excessive height of action is not a requirement. The trot is the usual gait. Good manners without severe bitting are a requisite. Roadsters should take the turns without breaking their gait and be able to sprint on turns or the straightaway, if called upon to do so. Most horse shows provide classes for roadsters 15-2 hands and under and for roadsters over 15-2 hands.

An outstanding Hackney Pony

"Crystal Lady" one of the "greats" of the Hackney ponies. A noted winner in Canada and the United States. Retired after the show season of 1953.

7. Heavy Harness or Carriage Type

(a) The Hackney

Thoroughbreds played an important role in the development of the Hackney. Although this breed is now regarded as a carriage type, it was once used for saddle purposes. In early days the poet, Chaucer, used the term "hackenay" to designate a "saddle horse" as distinct from a war horse.

With the improvement in roads, Hackneys were used in harness to a greater extent and their naturally high-stepping proclivities were cultivated. Although this peculiar action is inherited, Hackneys require special and skilful training to bring it to a high state of perfection.

Hackney horses should be serviceably sound, well balanced in conformation, refined about their fronts and clean in quality of bone and joints. Correct folding of the knees and flexing of the hocks are features of the stride.

In the show ring, Hackneys are usually hitched to fairly light, wire-wheeled buggies called viceroy wagons, but in some classes, are shown in wooden-wheeled vehicles such as two-wheeled gigs or George IV lady's phaetons. When Hackneys are lined up in the ring they "spread" by extending the fore legs forward and the hind legs backward. This habit dates back to the days when carriages were in general use; horses were taught to spread so that they could not move suddenly when a lady was stepping into or out of the carriage.

8. Ponies

The following breeds of ponies are recognized by the Canadian Pony Society, —Shetland, Welsh, Dartmoor, Exmoor, Iceland, Highland, Dale, Fell, Polo and New Forest.

Hackney ponies are smaller additions of the large Hackney horse, hence are not considered in the same category as the ponies mentioned above.

In Canada, Shetland ponies must not exceed 11 hands in height, and in the United States, 11.2 hands. Because of their small size and docility, these ponies are favourites with children and for children's classes at shows.

FEEDS, FEEDING AND MANAGEMENT

1. General Considerations in Feeding Horses

(a) Order of Feeding and Watering

There is some difference of opinion respecting the order of giving water, hay and oats to horses. Nevertheless, practical experience and experimental work would lead to the conclusion that water should be given first and feed shortly afterwards.

A horse usually raises his head at least once while watering. Consequently, he should not be taken from the trough when he first ceases to drink. An overheated horse should be allowed to drink a little at a time, but often, until he cools out.

(b) Feeding According to Work

The capacity of horses' stomachs ranges from twelve to sixteen quarts. As a general rule, the stomach is seldom more than two-thirds full; when this point is reached the feed passes out of the stomach at about the same rate as eaten. In view of this situation, horses at heavy work, or horses performing in races or show rings, should receive more oats and less roughage per 100 pounds of body weight than horses that are not engaged in strenuous exercise.

(c) Avoid Sudden Changes in Feeding

A quick change from old oats to oats that are newly threshed, may result in digestive disturbances such as colic. Similarly, sudden changes from old to new hay should be avoided. During any changing over process, the new feed should be blended with the old, and the percentage of the new feed increased gradually until it replaces the old feed completely.

Horses brought in off pasture in the fall of the year are likely to develop colds and coughs if closely confined during the first stages of the change-over from summer to winter environment.

(e) Use a Variety of Feeds.

A ration should contain enough bulk for safety in digestion, a high degree of palatability and a variety of feeds. Unless several feeds are included, the ration may not contain the proper amounts or proportions of the various nutrients.

Precaution

(i) It is more dangerous to feed a horse wilted grass than fresh grass.

(ii) Horses that have been on pasture for a period of time are likely to choke upon being fed grain.

(f) Bedding

The provision of good bedding is an important detail in horse management, because it encourages horses to lie down and rest their legs. It also protects their knees and other parts from injuries which might result from coming in contact with hard floors.

Wheat straw makes the best bedding provided that enough can be supplied to permit frequent changing. Although oat straw is slightly more effective in absorbing liquid, it is more likely to be eaten. Barley straw is unsuitable due to the fact that the awns may irritate the mouth parts if eaten.

Eating bedding may become a habit with horses that are kept in box stalls. This may be due to an excessive appetite, but is usually caused by lack of bulk in the ration. As a general rule, the habit can be cured by increasing the hay portion of the ration. If this does not prove effective, the horse should be bedded with peat moss, shavings or sawdust.

2. Feeds

Feeds for horses may be divided into two categories:

(a) concentrates, and

(b) roughages and succulent feeds

(a) Concentrates

(i) Oats—Oats are the standard with which all other concentrates are compared. They are the safest of all grains because they form a loose mass in the stomach, thus can be digested easily. Feeds such as corn or barley tend to pack, occasionally causing colic. Some horses are inclined to eat their oats too rapidly, thereby failing to chew them properly. This habit can be corrected by mixing some cut hay with the oats, or placing smooth stones in the feed box.

Although there is some difference of opinion regarding the advisability of crushing oats for horses, experimental work indicates that their value is increased 5-10% by crushing or coarse grinding. In any event, it is advisable to crush the oats being fed to old horses and foals.

(ii) Corn—Ear corn is a safer feed for horses than shelled corn due to the fact that it keeps better and must be chewed more slowly and thoroughly. Even so, corn should not constitute more than 25 per cent of the grain ration.

(iii) Wheat Bran—Because of its bulk and laxative properties, wheat bran is one of the most useful feeds for horses. Mixed with oats, it may be fed regularly, otherwise it should be fed once per week in dry form or as a bran mash.

(iv) Linseed Meal—This concentrate feed is highly recommended as a conditioner for run-down horses or as a means of putting bloom and finish on horses that are being fitted for show purposes. In such cases, the quantity fed should range from one-quarter to one-half pound per day.

(v) Molasses—This syrupy feed, which is usually classified as an appetizer or conditioner, should be diluted with water and mixed with other feeds. Up to one pint per horse per day, divided into three feedings, gives satisfactory results.

(b) Roughages

(i) Hay—Hay is the basic roughage for horses. The kind and amount fed will depend upon the type of horse and the work being done. It is customary to feed slightly more hay at the evening meal than at either of the other meals. Timothy has always had a high rating because of its freedom from mould and dust. Mixed hay containing timothy and legumes has a higher feeding value and is less constipating than timothy. On the other hand, timothy is preferable to early cut mixed hay for horses at work or in training.

(ii) Oat straw and wheat chaff—Feeds in this group provide a maintenance ration for horses which are performing little or no work, otherwise they have little value in horse feeding.

(iii) Succulent feeds—Carrots, turnips and mangolds may be fed to horses during the winter months. They aid in digestion, hence have a special significance in the feeding of in-foal mares and growing horses. However, they have a very limited application in the rations of horses at hard work. One or two turnips, or an equivalent weight of carrots, may be fed daily with safety.

Pasture is an excellent succulent feed and horses should have access to it whenever possible during the grazing season.

Caution

(i) Mouldy feeds may cause poisoning; dusty feeds may be responsible for the development of heaves. Hence, mouldy or dusty feeds must not be offered to horses.

(ii) A horse requires cobalt-iodized salt in amounts varying from one to two ounces per day. Some horsemen prefer to give the salt with the feed, others allow free choice.

(iii) If minerals are required, a mixture of salt and bone char, (equal parts by weight) fed at the rate of one to two ounces per day will usually suffice. If bone char is not readily available feeding bone meal may be substituted; some horses, however, object to the slight odour of bone meal.

3. Preparation of Feeds

(a) When cut hay is mixed with the grain ration, the rate of mastication is reduced. If the mixture is sprinkled with diluted molasses, it becomes more palatable. Although the extra work involved in preparing the feed in this manner is justified under special circumstances, the practice is not generally recommended. As a matter of fact, most horses prefer long hay.

(b) The crushing of oats for horses with good teeth may not be warranted, but it is advisable for old horses and foals. Furthermore, oats containing barley or wheat, even in small quantities, should be crushed. If the practice of feeding crushed oats is adopted, it should be continued each day of the week; it is very bad practice to change from crushed oats to whole oats on alternate days.

(c) Cooking grain is not practiced very extensively at the present time. Inasmuch as cooked grain can be fed with safety in fairly large quantities it is a favourite feed among those who are fitting horses for show or sale. The value of the boiled feed is enhanced by the addition of 1/3 to 1/2 cupful of flax to each pail of grain.

4. Rations for the Horses

A ration is the amount of feed given in a twenty-four hour period, regardless of the number of feeds. There is no hard and fast rule for feeding; it is considered advisable to adjust the ration to the size and age of the horse and the severity of the work which it is being called upon to perform.

Horses at hard work should receive from one to one and a quarter pounds of hay and one pound of oats for each 100 pounds of live weight. Horses in fat condition will not require as much feed. If for any reason the grain is fed a lower rate than suggested above, the amount of hay should be increased slightly. A little grain fed regularly is much more satisfactory than heavy feeding on work days and none at other times. It is false economy to deprive the horse at work of the grain portion of the ration.

(a) The following rations are suggested for draft horses:

(a) For 1,500 pound horse at hard work

Mixed Hay	14-16 pounds
Oats	13-15 pounds

(b) For 1,500 pound horse at medium work

Mixed Hay	16-18 pounds
Oats	9-11 pounds

(c) For 1,500 pound horse at light work

Mixed Hay	20 pounds
Oats	7 pounds

N.B. In all rations listed above, salt and water should be given as required.

(b) Suggested rations for Light Harness, Carriage or Saddle Horses

Style and action are of major importance with horses of this type. Too frequently, they are over-fed and under-exercised. According to an old Arab saying, "Rest and fat are the two greatest enemies of the horse".

On days when a light horse is not being driven or ridden, the usual amount of roughage may be fed, but the amount of grain should be reduced. Since horses of this type must be trim in body, they should not be fed large quantities of bulky feed; nevertheless, a reasonable amount of roughage is necessary.

From 10-12 pounds of hay is considered a liberal allowance. Since light horses usually have ample time for meals, long hay may be fed. Oats should be fed at a rate of 6-10 pounds daily with the actual amount being dependent upon the size of the horse and the nature of the work. It is advisable to divide the grain into three feeds. As an alternative to oats, a mixture consisting of three parts of oats and one part bran is recommended.

The amount of feed required by ponies will vary with the breed and type. As a general rule, 4-8 pounds of hay and 3-6 pounds of grain daily will suffice. Children's ponies should not receive much grain, as it tends to make them too spirited.

5. Conditioning the Horse

A "green" horse fatigues more rapidly than one that has been conditioned because his muscles are softer and carry an excess of fat. By working such a horse moderately, with properly spaced periods of rest, it is possible to build up the muscle cells to a point where the horse will do as much work as the seasoned animal. Rest provides strained muscles with an opportunity of repairing themselves. Inasmuch as fatigue increases with the square of the work done and not in the direct proportion, sustained muscle effort can produce disastrous results.

If harmful fatigue is to be avoided, a horse starting a day's work, either in harness or the saddle, must be warmed up gradually. It should be worked at a moderate speed, in order to keep a balance between muscular activity and ability of the blood to provide fuel and remove waste material. It must never be called upon for its best effort until thoroughly conditioned and then only after it is properly warmed up. It is equally important that it be cooled out gradually at the conclusion of each performance.

It is difficult to overwork a saddle horse that has been thoroughly conditioned provided it is being adequately fed and watered and is properly ridden. The latter term implies that the horse will not be allowed to trot over 9 miles per hour; that it will not be called upon to perform on hard ground or pavement, except for short stretches; that it will not be trotted downhill, and that it will not be required to carry a rider who is obviously too heavy. If these precautions are observed the rider will probably tire before the horse.

Exercise should be started and finished at the walk; in fact, horses should be allowed to walk the first half-mile and the last mile. They should not be required to trot on pavement or downhill, as this tends to increase the concussion on the feet and front legs. Girths should be examined at the end of the first mile and adjusted, if necessary.

When a horse is trotting, a good rider can ease the strain on its fore legs by rising from the saddle occasionally. This action on the part of the rider should be synchronized with the movement of the horse's fore-legs. It is rather important for the rider to rise at the time one fore-leg strikes the ground. However, he must alternate his rising movements, otherwise he will always be easing the strain on the same foot.

A saddle horse requires about two hours' exercise per day, while approximately three hours' work is necessary to keep a hunter or polo pony in condition.

6. Grooming

Some Scottish grooms have a saying that "a horse should be groomed from the inside out". In other words, the coat should be kept in good condition by proper feeding. The skin of a healthy horse is loose, supple and easily moved about; the coat is smooth and glossy, but in winter may become coarse and heavy. Horses shed their coats in the spring and autumn; the forelock, mane, tail and eyelashes are not shed. The more work a horse does, the more he sweats, hence the greater the need for grooming. In view of the fact that a horse has well-developed sweat glands, grooming should be thoroughly done for cleanliness and appearance, to prevent skin diseases and to remove scurf, loose hairs and waste products such as skin secretions.

To judge the cleanliness of a horse, the hand may be passed the reverse way of the hair with the finger tips pressed against the set of the coat. If lines of gray are left on the skin, or if gray scurf clings to the points of the fingers, grooming has not been done efficiently. Quite frequently, the area between the lower jaw, inside the ears, the bends of the knees and hocks, under the belly and between the fore-legs and thighs, are neglected. Before going into a show ring the nostrils should be cleaned out and all bedding removed from the soles of the feet.

Occasionally, horses will break out in a secondary sweat after they have been cooled out. This is not a normal condition and may be caused by overwork previous to the horse becoming properly conditioned or by nervousness.

It may also be caused by pain; if so, it indicates that the horse may be suffering from indigestion or colic.

Horses may be thin and out of condition as a result of the following:

(a) overwork

(b) being fed a ration (including water) which is too large or too small

(c) being fed a ration which is unsuitable

(d) irregularity in feeding and lack of attention to other details associated with management

(e) lack of sleep—a mature horse requires 5-7 hours of sleep every twenty-four hours

(f) sore shoulders caused by poorly fitting collars

(g) teeth which do not meet properly—particularly in the case of horses that slobber when they eat.

(h) internal parasites.

7. The Care and Feeding of the Stallion

Care and feeding exert a powerful influence on a stallion's performance at the stud. Although he should be kept in good condition, caution must be exercised lest he become too fat. Careful feeding, plenty of exercise, regular and thorough grooming and sensible regulation of service are essential to success as a "foal getter".

A stallion at heavy service requires a ration similar to that being fed to a horse at hard work. Oats, bran and mixed hay are quite suitable; however, the amounts will depend upon the breed, the temperament, the number of services and the amount of exercise.

It is advisable to divide the ration of a stallion at heavy service into four feeds. The largest portion should be given at the night feeding, otherwise he may be required to breed when his stomach is full. During the breeding season, a warm bran mash on Saturday nights serves as a beneficial substitute for the usual feed of oats.

Although a stallion requires special care throughout the breeding season, his ability to settle mares is determined, to a large extent, by the treatment which he receives in the preceding months. Regular, daily exercise is essential during this period. It may be provided by walks, by being ridden or driven, or by being turned loose in a paddock.

In draft breeds, a well-groomed two-year-old stallion may be bred to a limited number of mares, preferably not more than ten; a three-year-old may breed up to fifty and a mature stallion from seventy-five to one hundred. However, the number bred by stallions of any age should be governed by the length of the breeding season and the number of mares returning for service.

8. Feeding and Management of the Brood Mare

The in-foal mare should be kept in good condition at all times—never too fat nor too thin. Inasmuch as she is expected to produce a strong, healthy foal, she should be required to take exercise daily. Her diet must be watched carefully, with particular attention being paid to the quality of the feed.

The following ration is recommended as being suitable for draft brood mares:

(a) Hay—16 pounds, fed in two feeds

(b) A mixture containing 9 pounds of oats and 3 pounds of bran, fed in three feeds.

(c) Salt and water as required.

Brood mares may not require a mineral mixture, particularly when the feeds have been grown in soil that has been properly fertilized. However, if the quality of the feed is in doubt, minerals should be supplied. A suitable mineral supplement can be provided by mixing cobalt-iodized salt and bone char, equal parts by weight. If bone char is not readily available feeding bone meal may be substituted but this is not quite as palatable. Commercial mixtures may be preferred; if so they should be fed according to the manufacturer's directions.

In addition to salt, and possibly some other minerals, the brood mare should receive about ⅛ ounce of potassium iodide twice during each winter month commencing with October. This quantity may be added to the drinking water and mixed thoroughly. Inasmuch as it changes the taste of the water, the mare may refuse to drink; however, the refusal will be of short duration if other sources of drinking water are denied to her.

Precautions should be taken lest the foal develop joint ill or navel ill as it is sometimes called. It is caused either by a pre-natal infection or an infection of the navel cord after birth. Brood mares may be inoculated with a vaccine which is proving reasonably effective in the prevention of the disease. In view of the fact that losses are severe where no preventative measures are taken, owners of brood mares should consult their veterinarians well in advance of the date on which the foal is expected, and be guided by their advice.

Frequently, constipation is a threat to trouble as foaling time approaches. As the eventful day draws near, the amount of oats in the ration should be reduced and replaced by an equal quantity of bran. Actually, it is preferable to feed the bran in the form of a mash because its laxative effect is greater when fed in that form. Good pasture is an excellent insurance against constipation.

The formation of wax on the teats indicates that the foal may be expected within a few days—usually within twenty-four hours. Other signs are,—a filling of the udder and teats in the absence of the customary wax formation, and a swelling of the legs and abdomen. When the udder fills, it is unwise to attempt to extract milk from it, as such action may stimulate milk secretion and cause a leakage of the first milk or colostrum which is so necessary to the new-born foal.

Immediately previous to foaling, it is advisable to place the mare in a well-lighted, roomy box stall that has been thoroughly cleaned and disinfected. The box stall should be at least 12 feet square,—larger if possible. Clean oat or wheat straw is satisfactory as bedding. Inasmuch as the floor becomes quite wet during the process of foaling, there is less likelihood of the mare or foal slipping on an earth floor than on a concrete one. Regardless of the nature of the floor, it should be well covered with bedding to absorb the moisture and to reduce the danger of injury from slipping.

When foaling actually starts, the attendant should ascertain whether the foal is being delivered in the correct position, which is front feet first with the head resting over them. If the presentation is normal, the mare should be left alone. In a normal delivery, the act of foaling usually occupies less than one-half hour. Consequently, the mare should be watched constantly and if the foal has not been delivered at the end of that time, assistance should be rendered. Unless the attendant has had experience in dealing with such situations, it is advisable to secure the services of a veterinarian at once.

As soon as the mare is on her feet, she should receive one-half pail of warm water, then a warm bran mash made with one gallon of bran. In cold weather, the chill should be removed from the drinking water for several days after foaling, and bran should constitute at least one-half of the grain ration.

If a mare foals outside, certain precautions must be taken. Inasmuch as young foals should never be allowed to lie on cold ground, it becomes necessary to keep the mare and her young offspring inside at night and on cool, damp days.

Quite freqeuntly foals suffer setbacks from exposure to the hot sun, hence shade is an essential item in correct summer management.

Retained afterbirths in mares are not very common, but may prove rather dangerous. If not properly attended to, they result in difficulty in getting mares in foal again, or in serious complications, such as founder. If the afterbirth does not come away within six hours, a veterinarian should be called in.

Brood mares usually come in heat on the ninth or tenth day after foaling. If no difficulty has been experienced at foaling, the mare can be re-bred with safety at that time, preferably near the end of the period. However, if any complications develop it is inadvisable to breed her until some future heat period.

A few mares do not show any apparent signs of heat while nursing foals. In such cases it may become necessary to have a veterinarian determine when the mares are actually in heat. However, approximately 90 per cent of the mares that are not bred on the ninth or tenth day and those that were bred and failed to conceive, will come in heat between the 25th and 30th day after foaling.

A mare that has been bred should be checked daily for evidence of coming in heat between the 18th and 24th day following breeding, and at weekly intervals thereafter until the 42nd day. At the end of that time, a veterinarian should be called in to make a pregnancy diagnosis. Unless this check is made, the mare may remain idle for a year.

Although mares may be bred at any time of the year, draft mares are usually bred to foal in April, May or June. In the case of light breeds, particularly breeds that are being raised for racing purposes, foals are dropped earlier, but after January 1st, the base date for reckoning the age of a horse. The gestation period is 340 days or approximately 11 months.

9. Care of the Foal

It is rather important that the foal be born in clean, well-disinfected quarters, otherwise it may become the victim of infection. Usually, the navel ruptures when the foal begins to move about. If so, a reliable disinfectant, such as a 2½ per cent iodine solution, should be applied to the navel stump as soon as possible, and the applications continued daily until it has healed. Care must be taken in applying the disinfectant lest some of it get on the foal's belly where it could cause severe burns.

In cases where the navel does not rupture the blood should be pressed out of the vessels in the navel cord into the afterbirth. A string, which has been dipped in an iodine solution, should then be tied around the cord about one inch from the belly and the cord severed at a point about one inch below the ligature. As a general rule, the string should not be allowed to remain around the navel cord for more than twenty-four hours.

The navel stump must be watched carefully. If it continues to leak, or remain damp, it is advisable to have it treated by a veterinarian. Joint-ill or navel-ill, a condition which may develop as a result of navel infection, is characterized by a stiffness or soreness of the joints and a rise in temparture above the normal for a foal which is 100.5 degrees Fahrenheit.

The foal should get some colostrum or first milk soon after birth. Occasionally it is difficult for the new-born foal to nurse. Considerable patience may be required in getting it started. Even so, every effort should be made to get some colostrum into its stomach as soon as possible. If it cannot get up under its own power, the attendant should help it to its feet. If it cannot, or will not, nurse in the natural way, it should be bottle fed with the first milk from the udder. Whenever possible, the bottle to which a large nipple has been attached, should be held under the mare's flank so that the foal will be required to assume a position closely resembling the one occupied in nursing. After a few such feedings, the foal usually acquires the habit of nursing in a natural manner.

Foals must be watched for signs of constipation, the common one being straining and arching of the back. At the first indication of this condition, the foal should be given a tablespoonful of castor oil mixed with a small quantity of mare's milk. If this does not produce results, it may be necessary to give an enema, by injecting about one-half pint of water at body temperature into the rectum. In such cases it would be advisable for the inexperienced to consult the veterinarian immediately.

Foals born previous to the pasture season should be taught to eat feeds such as hay, oats and bran. Most foals acquire the habit of helping themselves from the dam's feed box. However, there is always the danger of foals gorging themselves, hence care must be exercised, lest they start eating too early, or eat too much.

Inasmuch as a foal is expected to make one-half his life-time growth before his first birthday, care and feeding during his first year is very important. Whether the mare and foal are fed grain while on pasture will be determined by the rate of development desired.

(a) Raising the orphan foal—

In cases where a mare dies or has no milk, it becomes necessary to raise the foal by hand, a job which is likely to test the patience of most men. Cow's milk having a low percentage of butter fat, if properly treated, makes an acceptable substitute for mare's milk. In its preparation, one tablespoonful of brown sugar should be dissolved in a small quantity of warm water, then the sugar solution and three to five tablespoonsful of lime water should be added to enough milk to bring the total quantity up to one pint. One teaspoonful of flax seed tea, made by adding one cup of flax seed to 2 quarts of water and allowing the mixture to simmer until it is cooked, may be added to this mixture. For the first few days, one-fourth pint, heated to body temperature, should be fed every hour. After the fourth or fifth day, feedings may be reduced to six and later to four times daily, provided the quantity given at each feeding is increased slightly. In the initial feedings, it is advisable to use a milk bottle and nipple, but the foal should be encouraged to drink from an open vessel as soon as possible.

When the foal is between 3 and 4 weeks of age, the practice of adding sugar may be discontinued but the lime water should be added for another 2 to 3 weeks. Flax seed tea may also be added during this period at the rate of 2 to 4 teaspoonsful per feeding. When three months old, the foal should be given all the whole milk or sweet skim milk it will drink in three feedings, and, of course, should have access to clean drinking water.

Lime water may be made by dissolving lime in water. After it has been allowed to stand for several hours, the clear liquid at the top of the container should be poured off and kept in tightly corked bottles for use as required.

By the time the foal is three months old, it should be eating solid food. Even so, its need for milk will persist for several months.

(b) Weaning

A foal that has nursed should be weaned when five to six months of age. Usually, the dam is taken away from the foal and placed where she cannot hear or see it. If the foal has learned to eat previous to the weaning, and most foals have, it should not suffer a set-back. However, the mare's udder must be watched; if it shows indications of filling or of getting hard and sore, the milk should be extracted.

In order to ensure proper growth following weaning, the foal should receive liberal quantities of those feeds which promote growth and development of bone and muscle. Good quality mixed hay, oats, bran and carrots or mangols are quite suitable. Regular exercise is of equal importance as this tends to condition the feet and legs. Draft foals may have all the mixed hay they will eat and from three to seven pounds of grain mixture consisting of three parts crushed oats and one part bran daily. The lesser amount is recommended for feeding in the late fall, but the quantity should be increased gradually throughout the winter with the six to seven pound level being reached by spring.

The same feeds are suitable for foals of the light breeds. However, the quantity of grain being fed will vary with the age of the foal, the breed and the amount of development desired.

During the second winter, draft colts should be given free choice of hay and from six to ten pounds of oats or an equal amount of oat-bran mixture daily. Oat straw, corn stalks or bean straw may be used as a substitute for a portion of the hay. Although these roughages can be used in feeding yearlings, they should not be included in the ration of weanlings.

(c) Summer Management

Yearlings and two-year-olds should be turned on grass early in the spring. Any decisions with respect to grain feeding will depend upon the breed and the amount of development desired at two years of age.

(d) Age to Castrate

Colts not intended for breeding purposes, should be castrated during the spring that they reach one year of age. Usually, there is a lack of development of the fore quarters, particularly the neck, when this operation is performed earlier. Occasionally, it may be advisable to leave them for a longer period of time, but in most cases this postponement causes them to become troublesome. After castration, the foal should be turned on grass to prevent swelling and infection.

(e) Care of the Feet and Legs

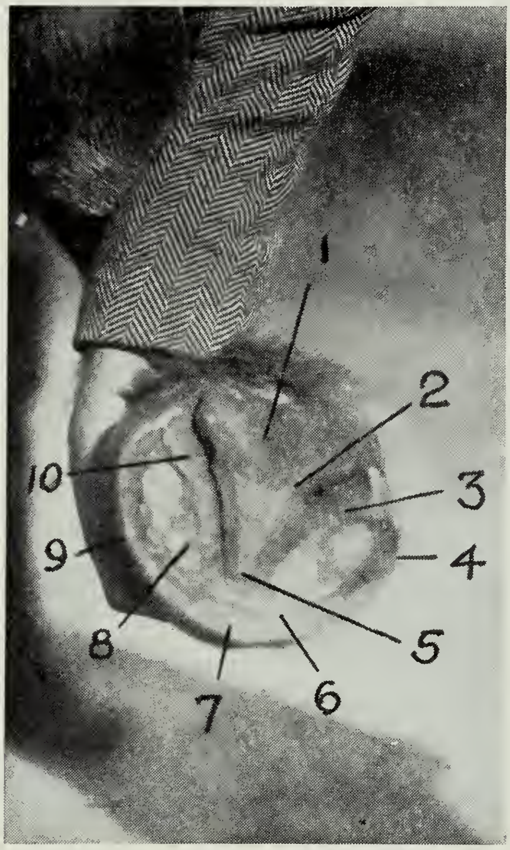
The statement has been made "that seventy per cent of the horse is his feet and legs". Even though the statement may be somewhat exaggerated, the time to start developing proper feet and legs is when the animal is young. Therefore, feeding and management practices which will produce sound limbs with good wearing qualities, as well as a sturdy body, should be adopted.

Colts should be fed hay out of a very low manger, or off the floor. Knees that are inclined to be weak will often strengthen when colts are fed in this way. On the other hand, the condition may become aggravated if the colt is required to reach upward for his hay.

A colt's feet must be trimmed regularly, otherwise he may not have desirable feet upon reaching maturity. In performing this operation, it is advisable to keep the heels as wide as possible. If a foal's feet are handled during the first year of his life, trimming becomes a simple matter thereafter.

A new-born foal has soft, horny material on the soles of his feet; this usually sloughs off in a few days and a new growth replaces the old. The feet begin to have more spread at the heel and more slope to the walls, hence tend to assume a rounder appearance. If the feet are not wearing evenly, a hoof knife or rasp can be used to level them. Proper trimming at this stage may correct minor faults in the feet and legs of foals, thereby forestalling the development of major faults in mature horses.

The frog, or centre area of the sole of the foot, is soft and spongy in texture and acts as a spring in relieving concussion. In order to keep it in a healthy condition, the horse should be shod so that the frog comes in contact with the ground or pavement at every step. At the time of shoeing only the ragged areas need be removed, as any other superfluous portions are shed in due course.



A photo of the bottom of a healthy foot.

1. Central Furrow.
2. Lateral Ridge of Frog.
3. Bar.
4. Outer Quarter.
5. Apex of Frog.
6. White Line.
7. Ground Border of Wall of Toe.
8. Sole.
9. Inner Quarter.
10. Lateral Furrow between Frog and Toe.

The sole is made of a hard, horny substance which acts as a protection to the lower surface of the foot. It is thickest at the toe and gradually becomes thinner at the heel. It should not be burned or whittled in shoeing. On the other hand, all dirt or loose material should be removed from the bottom of the foot; then it should be examined for any indications of thrush, a condition which frequently develops when the feet are not given proper care. It is manifest by a discharge of dark-colored, offensive-smelling pus from the cleft of the frog. In the early stages, treatment consists of cleaning and bathing the infected areas, then packing it with pine tar. However, in deep-seated cases, the advice of the veterinarian should be sought.

In shoeing, the next step consists of nipping the hoof wall down to about the same level as the sole. Then the surface should be smoothed off with a rasp until the heel and the toe are the proper length to give the foot the correct shape. When work on the bottom of the foot has been completed, the foot should be held in front of the colt and the lower edges of the hoof-wall rounded off with a rasp.

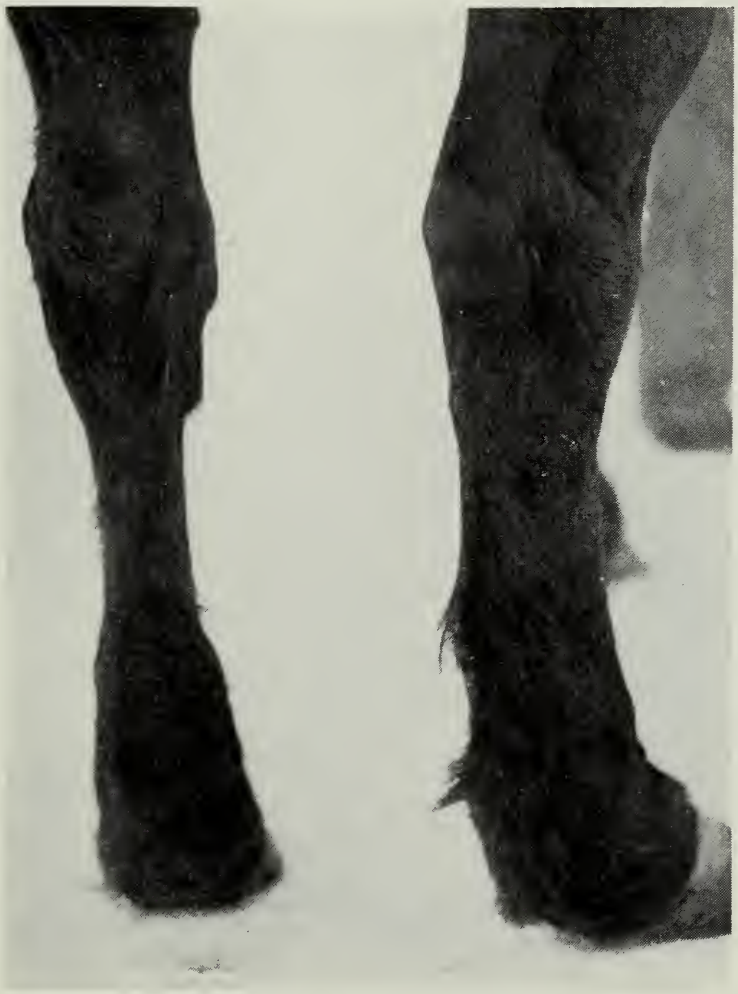
Occasionally, the feet of older horses become dry and hard. In such cases, it is advisable to pack the shoes with moist, blue clay at night. In severe cases, the horse should be required to stand in the clay for several hours. Hoof ointments also serve to keep the feet in good condition. Although some persons paint horses' feet with old crank case oil, the practice is not recommended. In all probability, the oil contains gasoline which may have a drying and hardening effect on the feet.

CONSIDERATIONS IN SELECTING HORSES AND STALLIONS

In order to determine a horse's true value it is necessary to examine him carefully, then to balance his good points against those which are less desirable. A thorough examination cannot be made unless the examiner has a comprehensive knowledge of those conditions which constitute unsoundness. He must also be able to differentiate between an unsoundness and a blemish. A blemish may detract from a horse's appearance, thereby depreciating his value, but it seldom interferes with his usefulness. On the other hand an unsoundness, whether it be inherited or acquired, invariably reduces the horse's ability to perform work.

1. Common Unsoundnesses

Some of the more common conditions described as unsoundnesses are as follows:



A well developed bone spavin. It may be plainly seen on the inside of the near hock. Note the short round conformation of the hocks which predisposes to unsoundness.

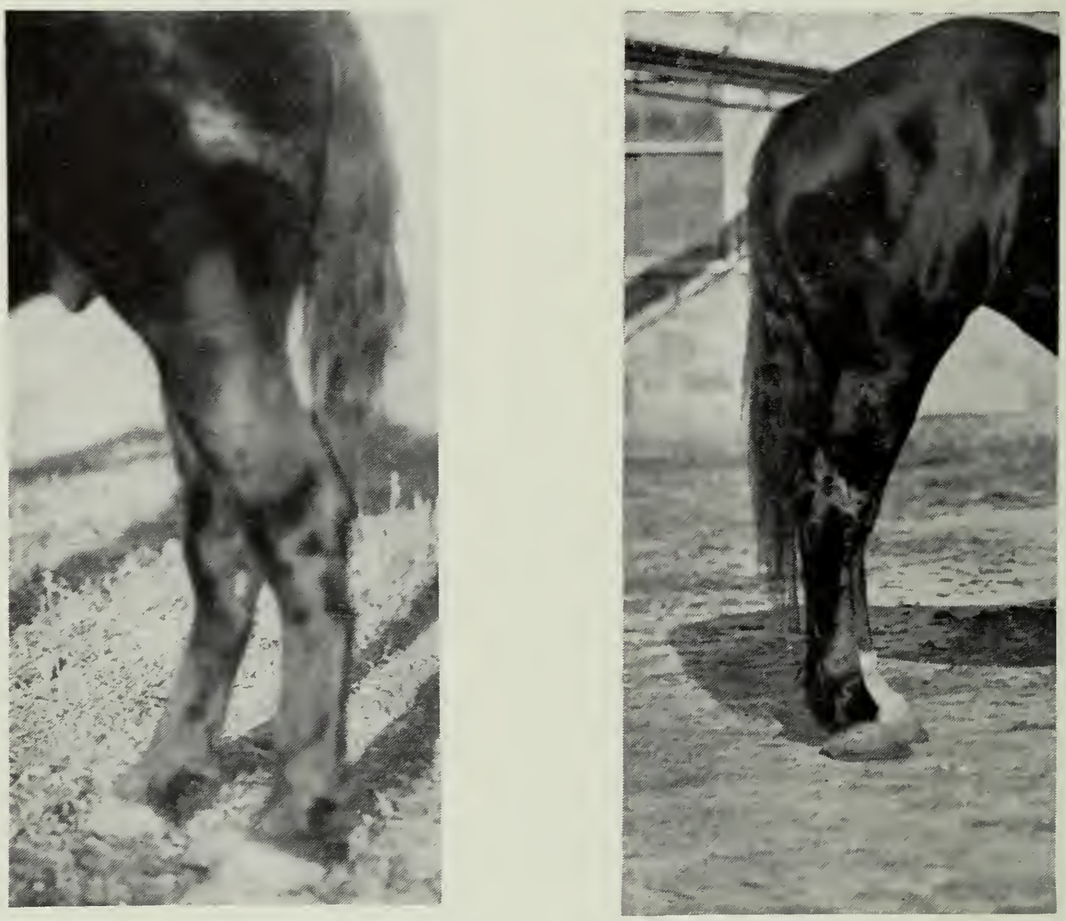
(a) Bone Spavin

Bone spavin, or jack spavin as it is sometimes called, affects the functioning of the joints in the hocks. Inasmuch as these joints are subjected to greater strain than most joints in the body, anything that prevents them from functioning properly will greatly impair the usefulness of the horse.

Bone spavin may be caused by anything that produces inflammation. The most common causes are faulty conformation, mechanical injuries resulting from kicks and blows or overwork on paved streets. Bone spavin consists of a bony deposit which nature probably intended to function as a support for a weak joint, but which unfortunately serves to cement the joints in the hock, thereby interfering with its action. Instead of the hind leg coming down on the heel, as it does in the case of a sound limb, the toe reaches the ground first; the stride is unnaturally shortened and lameness frequently results.

In order to detect bone spavin, the examiner should assume a position beside the horse which will permit him to see the inner outline of the hock.

Occult spavin, a form of bone spavin, is difficult to detect because the deposit is hidden in the joints. However, an affected horse will manifest a lameness upon being taken from the stable. If the condition has not become deep-seated, the lameness may disappear after the horse has been exercised.



The photo (left) shows weakly supported hocks predisposed to curbs and other unsoundness. The hind legs of this horse indicate a lack of strength. Contrast this with a normal pair of hind legs (right).

(b) Curb

A curb is found on the rear of the hind leg, immediately below the hock. Actually, it is a thickening of the ligaments of that region. By viewing the leg from the side, it may be easily detected, since its presence constitutes a variation from a straight line which normally extends from the point of the hock to the fetlock. Narrow, tied-in hocks are more subject to curb than those that are broad.

(c) Bog Spavin

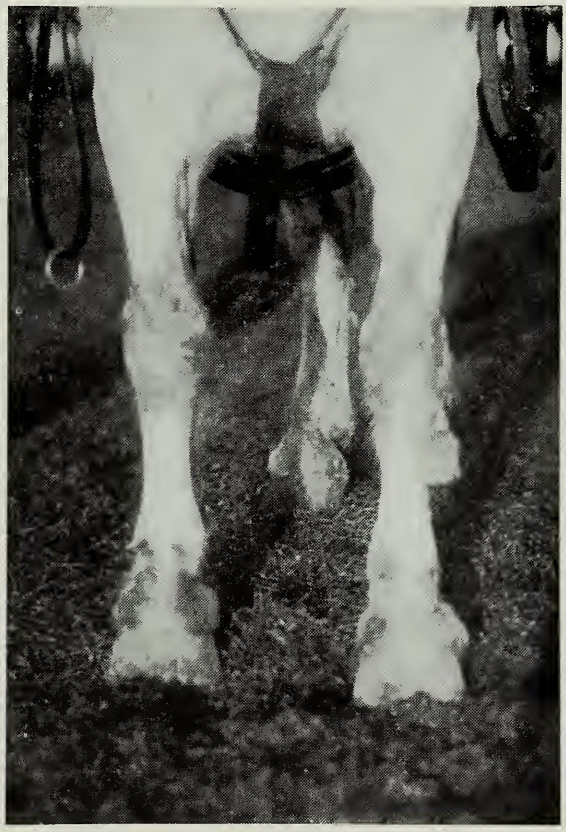
Bog spavin is located in the natural depression that occurs in the inner and front part of the hock. The synovial fluid from the joint accumulates and forms a large swelling, having a puffy appearance. This condition is usually associated with short, round hocks.

(d) Ring Bone

Ring bones are located on the pasterns,—usually, but not always, on the fore limbs. Short, upright pasterns are predisposed to ring bone formation. There are two forms of ring bone—the high and the low—so called because of their locations. Usually a ring bone is located at the point where the foot joins the pastern. As a general rule, it is quite prominent, hence easily seen; occasionally it is necessary to pass the hand over the joint in order to detect a small one.

(e) String Halt

String halt is characterized by a spasmodic jerking up of one or both hind legs. It is most evident when a horse is walking, turning on a small circle or backing.



An undesirable pair of front feet with four well developed side bones.

(f) Side Bones

Side bones are located on the hoof heads of the front feet. They are small, hard prominences which have developed as a result of cartilages becoming ossified. Frequently, side bones cause lameness, particularly when affected horses are driven on hard roads. They are often found on the outer corners of the heels of wide fronted draft horses, possibly because their weight is not distributed evenly on the feet.

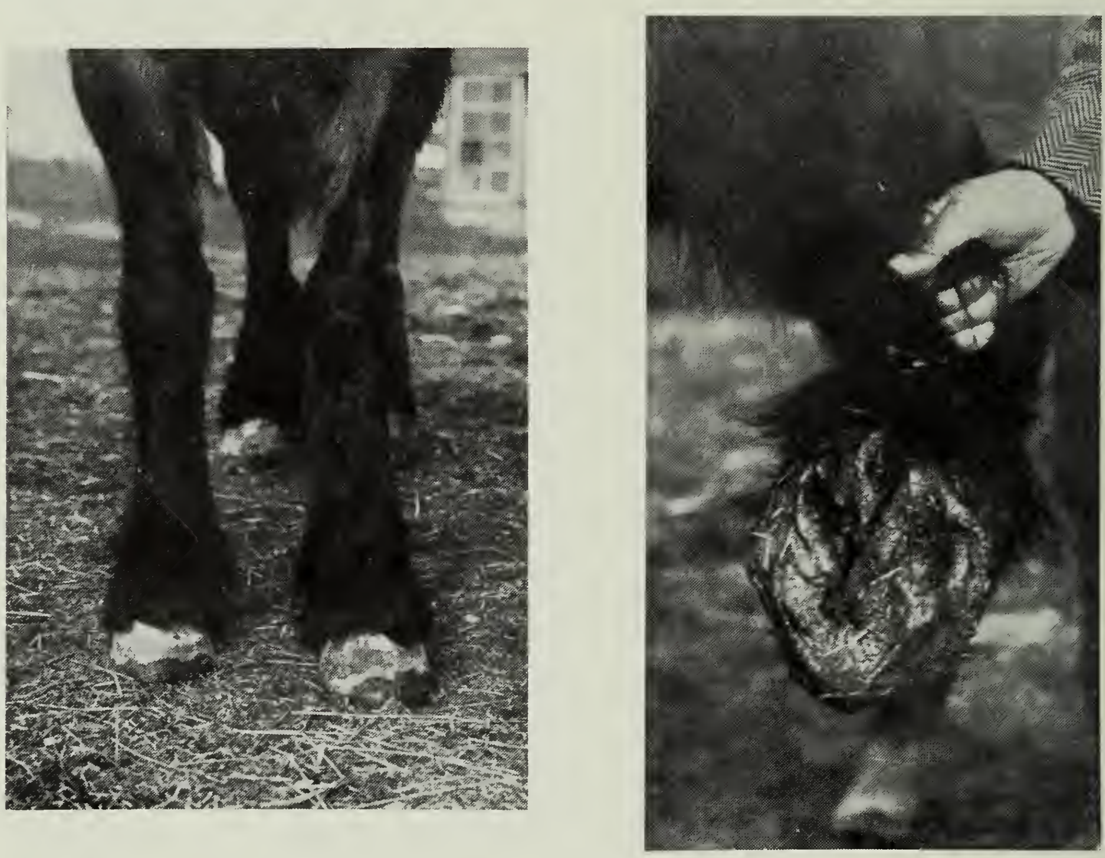
(g) Roaring or Whistling

The chief symptom of this condition is a roaring or whistling sound induced by a brisk trot or heavy work. In severe cases, the sound may be heard for a considerable distance. Undoubtedly, the condition prevents a horse from breathing normally.

(h) Periodic Ophthalmia

This disease is characterized by periodically occurring attacks of inflammation of the eye which eventually cause the horse to become blind. Infected eyes usually have a spherical pupil as contrasted with an elliptical one in the normal eye.

Invariably a horse will reveal the condition of his eyesight by his action. Stepping unusually high, or shying without any apparent reason are indications of defective vision. Blindness may be detected by moving the hand slowly in front of the eye. However, if the hand is moved too rapidly, air currents will be produced which will cause the horse to close his eyelids even though he may not see the motion of the hands.



The photo (left) shows the front feet of a horse affected with navicular disease. They have a narrow contracted appearance. The bottom of the foot (right) of the same horse shows a narrow contracted heel and a shrunken frog.

(i) Navicular Disease

In the early stages of this disease, the symptoms are scarcely noticeable. Without warning, the horse may limp, but after a few steps, he will regain his normal stride. In advanced cases the horse becomes lame, the heels contract, the hoof becomes hard and dry, the frog dries up and the toe strikes the ground first.

(j) Other Undesirable Conditions

In addition to the unsoundnesses referred to heretofore, several other conditions should be considered when examining a horse. Although these conditions are normally classified as unsoundnesses, they are equally undesirable, and horses that are affected with them have a greatly reduced value.

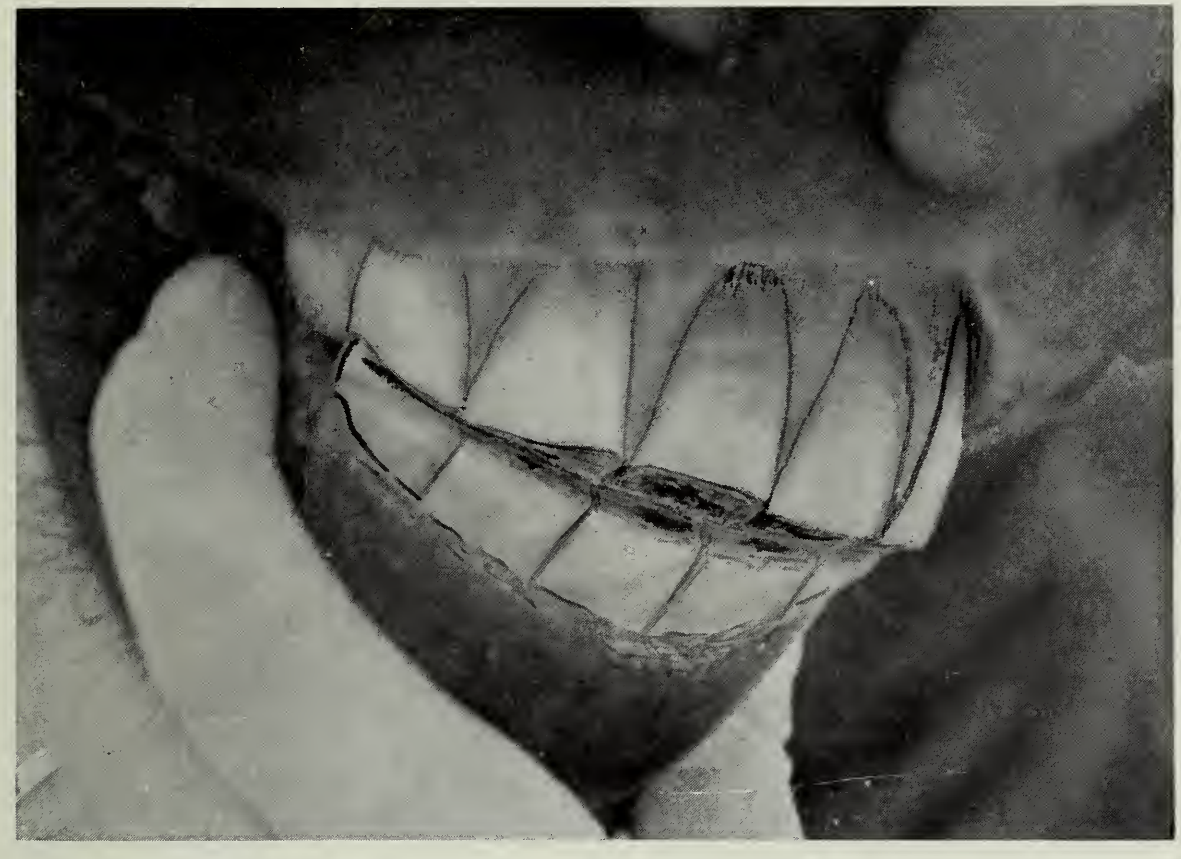


Photo showing the teeth of a horse that cribs. Note the broken appearance on the outer part of the teeth.

(i) Has the horse any stable vices, such as cribbing? In seeking the answer, examine the stall for evidence of biting and chewing, and the horse's mouth to ascertain whether the teeth and jaws are normal in shape.

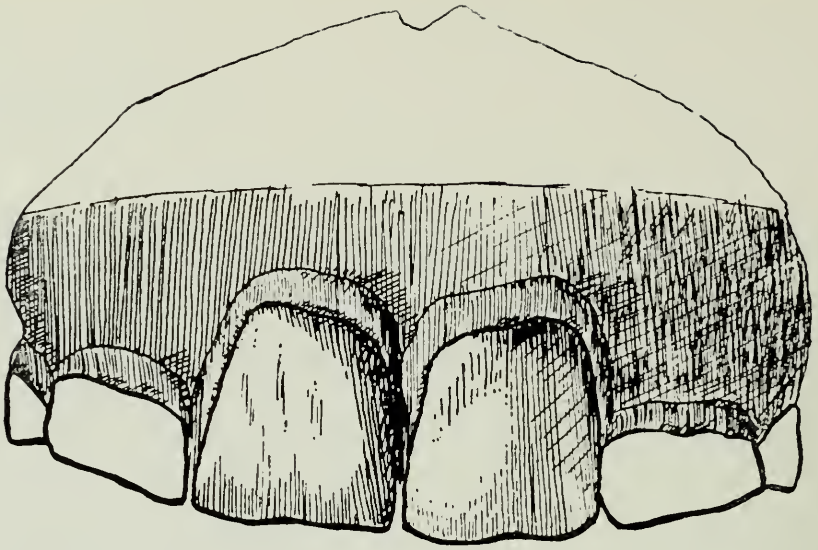
(ii) Is the horse a grunter? To find out, take the lead strap in one hand and with a stick or cane held in the other hand, make a false pass at the horse. It is generally believed that a grunting horse will eventually become a whistler or roarer.

(iii) Is the horse affected with heaves? This condition is evidenced by abnormal breathing. Upon watching the flank movements, it would appear that the horse inhales normally but experiences a double spasm in exhaling.

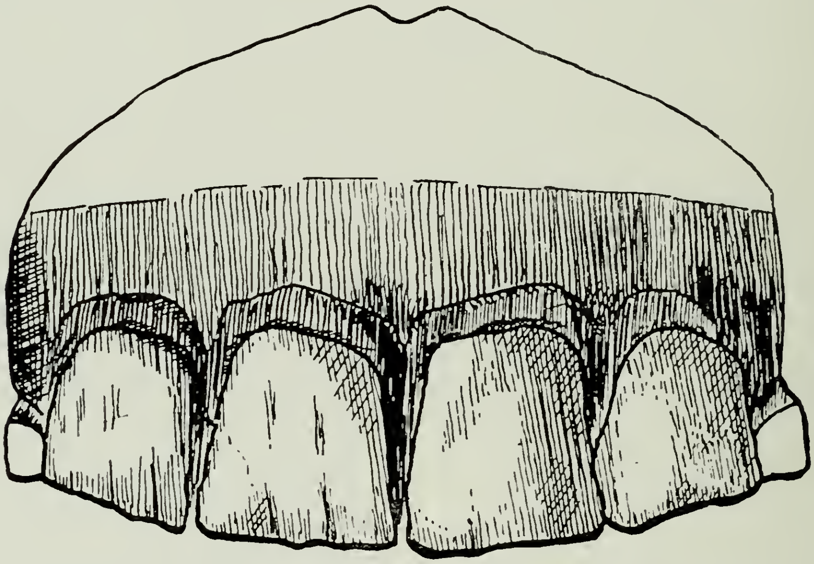
(iv) Can the horse back up properly? Are his stifles right? Never buy a horse without testing for these conditions.

(v) Are the front feet sound? About two-thirds of the weight is carried on the front feet. Hence, they should be examined for evidence of founder, a condition which is indicated when the ridges on the hoof tend to come to a point at the front of the foot.

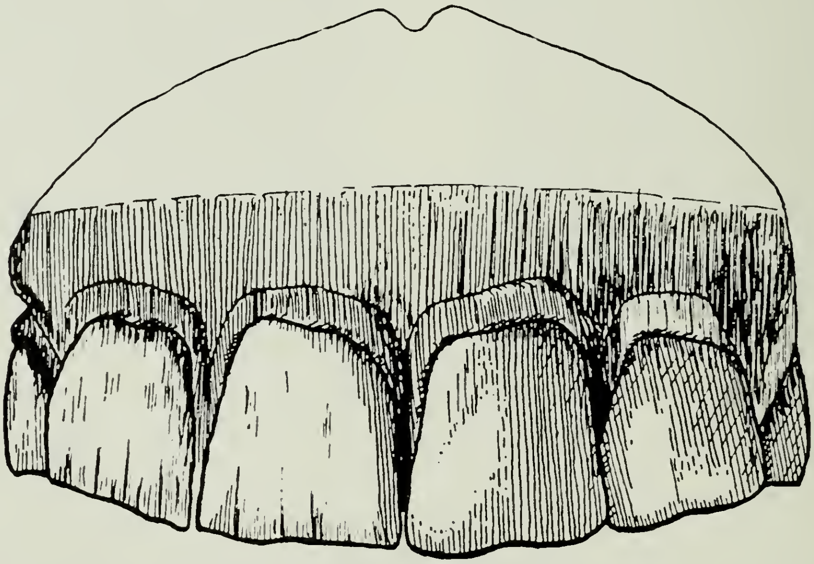
(vi) Has the horse a good disposition? A horse can learn bad habits. Unfortunately, he doesn't readily forget them. Consequently, a bad tempered horse has very little value, regardless of his type, conformation or soundness.



Three-year-old mouth showing first pair (centrals) of permanent incisors.



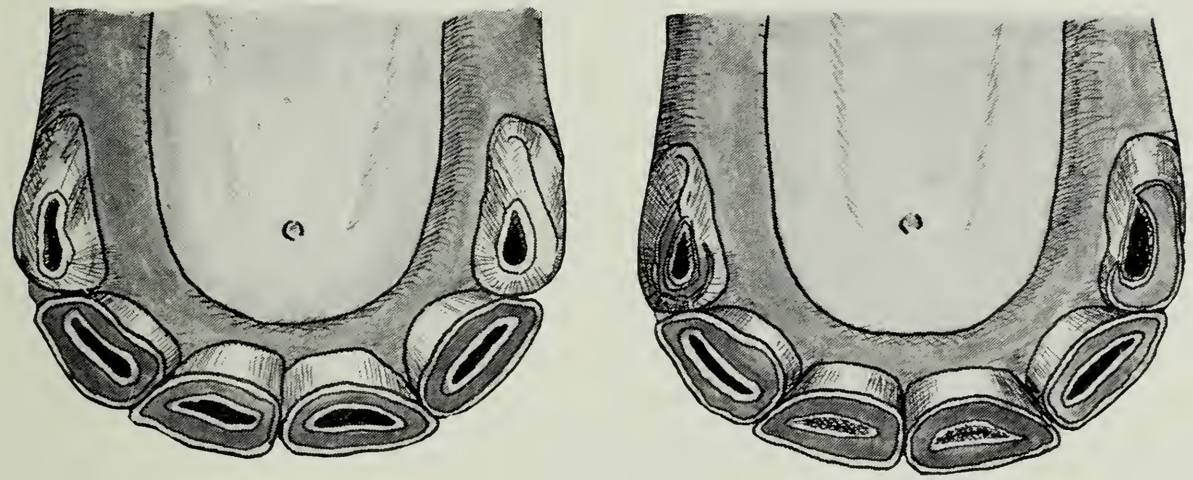
Four-year-old mouth. The second pair (laterals) of permanent incisors are in place.



Five-year-old mouth. The horse has now a full mouth, or all his permanent incisors. The corners are in place.

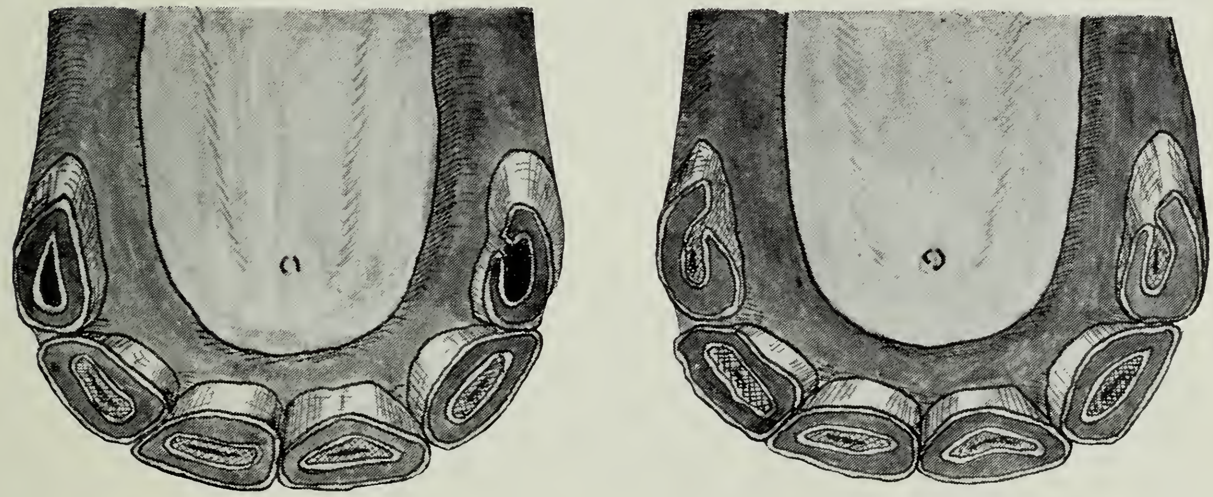
2. How to Determine a Horse's Age

Inasmuch as a horse's value depends, to a considerable degree, upon his age it is important that persons who may have occasion to purchase horses be able to estimate their ages. Usually, some indication can be obtained from their general appearance; for example, it is quite possible to distinguish between a colt, a young horse and an old horse. However, each of the latter two age-groups covers a span of several years, hence there could be a wide variation in the value of horses within either of these age-groups from the standpoint of age alone.



Five Years
Lower Jaw

Six Years
Lower Jaw



Seven Years
Lower Jaw

Eight Years
Lower Jaw

At five years the marks are quite distinct and the tables show practically no wear in any of the incisors. At six years the tables in the centre pair of the lower jaw show some wear, the marks becoming smaller. At seven years the second pair have nearly lost their marks, and at eight the corner pair show considerable wear.

Teeth provide the most reliable guide to the age of a horse. Nevertheless even the best judges may be deceived unless they have some knowledge of the conditions under which the horse was raised. Feeds have a marked influence upon the wear of the teeth. Pasturing on sandy soils may speed up the wearing-away process. Consequently, the teeth of horses that have been raised on certain types of feed or pasture may belie their ages. Although liberal feeding of young horses may hasten the development of incisors, they are not likely to appear more than six months before their normal time.

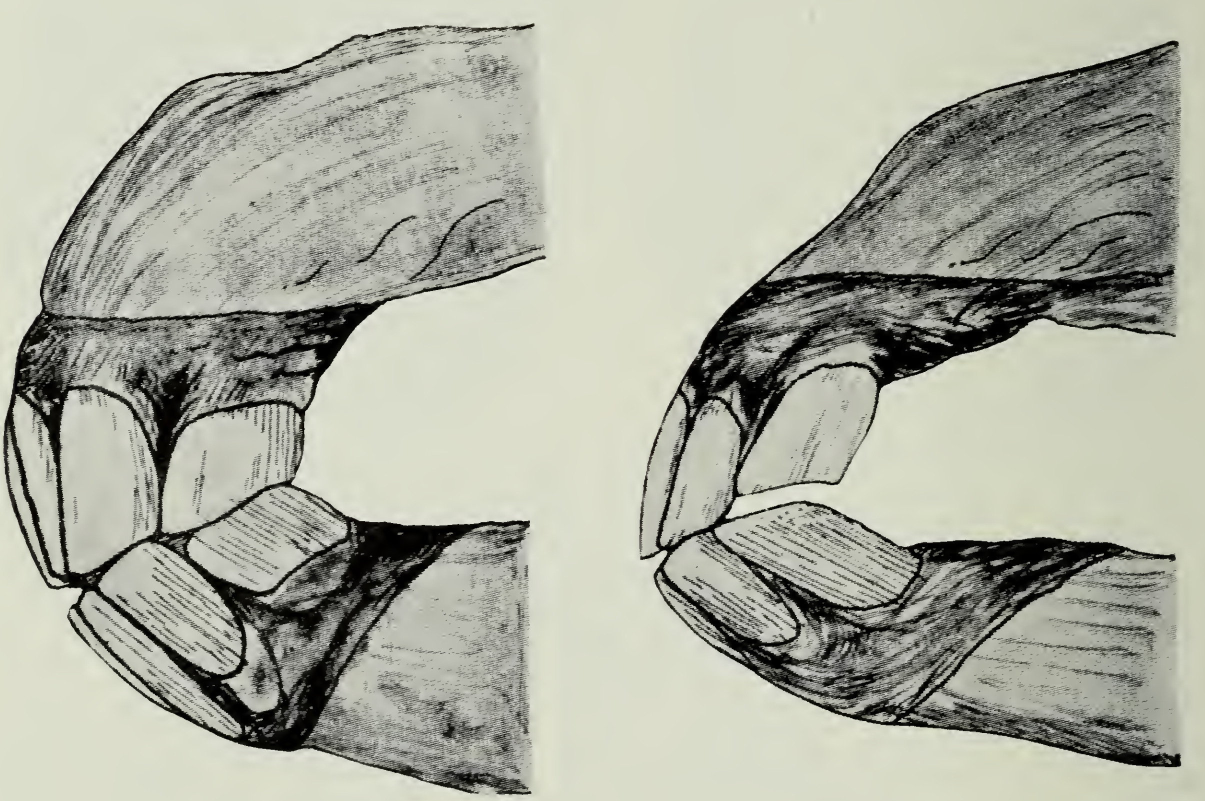
(a) Order of Appearance of Incisors

In the majority of cases, a foal has no teeth at the time of its birth, however it is not long before the teeth begin to appear. The first pair in each jaw usually erupt through the gums at ten days of age, the second pair about the thirtieth day and the final pair at six to ten months. These temporary incisors or milk teeth, as they are sometimes called, are narrow, slender and very white in contrast to the permanent teeth which are broad, thick and usually yellowish in colour.

The permanent incisors of the lower and upper jaw erupt in pairs and displace the temporary teeth, with each corresponding pair erupting at the same time. The centrals make their appearance first and are fully developed by the time the colt is between two and one-half and three years of age. The laterals, that is the teeth on each side of the central pairs, appear next and reach full development in horses ranging in age from three and one-half to four years. The corner teeth or outside pair make their appearance later and are fully developed in five-year-old horses. When these twelve incisor teeth have become fully developed the horse has what is commonly termed, "a full mouth".

The tushes or canine teeth usually start to appear when the horse is four years old. They are commonly found in males—occasionally mares have rudimentary tushes. When present, there are two in each jaw, with the ones in the lower jaw being closer to the incisors than the ones in the upper jaw.

Permanent teeth grow at the rate of one-eighth inch per year, which is more than enough to compensate for the disappearance caused by wear. As a consequence teeth become slightly longer as the horse grows older.



Five Years

Seventeen Years

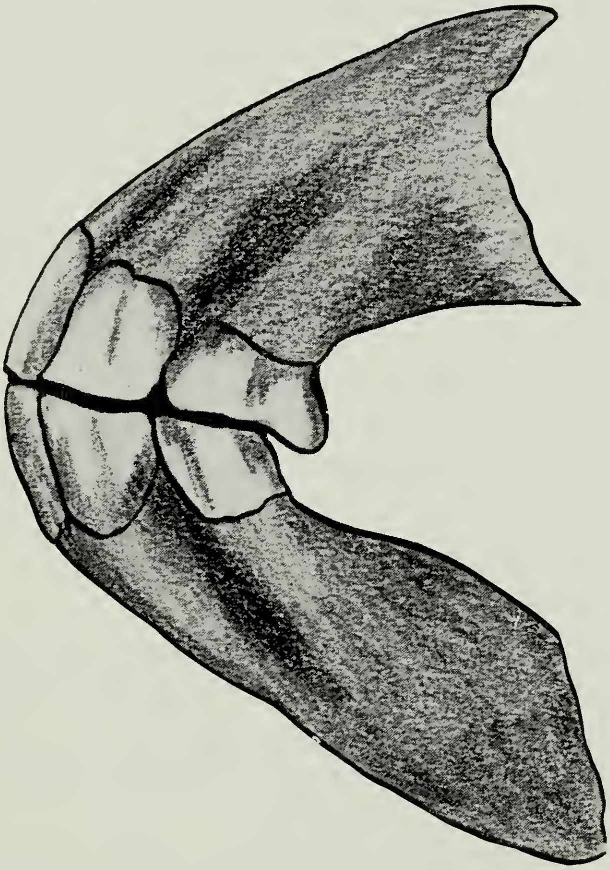
Comparison of a five-year-old mouth with that of a seventeen-year-old, showing the difference in shape as age advances. The teeth spring from the jaw with a much greater slope.

(b) Disappearance of Cups

Between the fifth and eighth year, age is indicated by the tables or cups on the biting surface of the incisors. At five years, the cups in the centrals of the lower jaw show some wear, and by the time the sixth year is reached they have almost disappeared. At this stage the tushes are well developed and their points have become quite sharp.

At seven years, the laterals lose almost all trace of their tables while the corner teeth have acquired a well marked dental table. The upper corner teeth have a dove-tail appearance, which is sometimes called the "seven year hook".

At eight years, the corners are almost free from any appearance of tables. All incisors show indications of wear and have become oval in shape. Careful examination will reveal that a brownish or yellowish brown linear streak, called the dental star, is running across the centrals between the inner and outer rings of enamel. Although this dental star is occasionally found in all incisor teeth at eight years, it is usually confined to the centrals or to the centrals and laterals. As a general rule, the seven-year hook has worn from the corner teeth, but on rare occasions traces of it can still be found in nine or ten-year-old horses.



Jaws of a seven-year-old mare viewed from one side. These jaws show the indentation of the upper corner tooth, called the dove-tail or seven-year-old hook.

After a horse has become nine years old, it is much more difficult to tell his age with any degree of accuracy. At nine years, the central and lateral teeth are more triangular and the inside angle has become rounded. The cavity has disappeared from the corner teeth and they now have acquired a dental star.

A small ring of enamel, almost circular in outline, is all that remains at ten years. The dental star is distinct on the lower incisors and occupies a more central position on the teeth. "Galvayne's Groove", a groove which protrudes under the gum on the outer surface of the upper corner teeth, appears as this age is reached. It continues to develop thereafter and extend about half-way down the teeth by the time the horse is fifteen or sixteen. Upon reaching twenty-five years, the groove starts to disappear and is no longer in evidence in a thirty-year-old horse.

3. The Stallions Act

Under the provisions of the Stallions Act, no person may stand, travel or offer for service or sale any stallion unless such stallion has been enrolled. In order to become eligible for enrolment, he must be pure bred, registered in the name of the applicant, inspected and approved. Upon being inspected, stallions which are considered suitable for use as sires are classified into Grades A, B or C by the Stallion Enrolment Board.

Grade A consists of stallions that are

(a) good specimens of their breed,
(b) free from hereditary unsoundness,
(c) smooth in conformation,
(d) straight and true in action, and,
(e) maintained in good breeding condition.

Grade B consists of stallions that are

(a) good specimens of their breed, and,
(b) free from hereditary unsoundness but may have a minor defect in
    (i) type,
    (ii) conformation, or
    (iii) size.

Grade C consists of stallions that are

(a) good specimens of their breed but have a hereditary unsoundness, or
(b) free from hereditary unsoundness, but are
    (i) undersized,
    (ii) plain in type, or
    (iii) rough in conformation.

Any stallions which do not meet the specifications for these grades are rejected and their owners are notified that they cannot be enrolled.

Stallions are inspected at three year intervals and maintain their grade classification for that period of time, unless re-classified as the result of a re-inspection made in the interval at the owner's request.

The Stallion Enrolment Board publishes a report annually in which are listed pertinent data with respect to all stallions enrolled during the year ending July 31st. The information contained therein is valuable to persons intending to breed mares and should be studied carefully by them when considering sires for the mare's next foal.

In view of the fact that good sound horses only are likely to be in demand at attractive prices and since unsoundnesses and other undesirable conditions can be transmitted from sire to offspring, grade A stallions should be used whenever possible.

DEFINITIONS OF COMMON TERMS

1. Aged Horse—correctly speaking, a horse over eight years of age, but the term is often used to indicate an old horse.

2. Brood Mare—a mare that is either raising a foal or is in-foal. Most shows require a brood mare to be shown with a foal at foot.

3. Colt—a young immature male horse, usually over one year of age. The term is used rather loosely to describe geldings and fillies up to three years old.

4. Colt foal—a male foal under one year.

5. Filly—a young immature female horse, usually over one year of age.

6. Filly foal—a female foal under one year.

7. Gelding (sometimes written "geld")—a castrated male horse of any age.

8. Mare—an adult female horse of any age.

9. Mare with foal at foot—dam and foal running together.

10. Rig, Ridgling or Crytorchid—a male horse having one testicle retained in the abdomen. Usually testicles descend into the scrotum before a colt foal is one year old.

11. Yearling—a colt or filly over one year and under two.

12. Yeld mare—a mare that has neither produced a foal nor is in-foal during a particular year.

COLOURS AND MARKINGS OF HORSES

Inasmuch as colour is the most conspicuous feature by which a horse can be described, it constitutes the most common method of identification. However, exceptions have been made by some breed associations which now require representatives of their breeds to be identified with tattoo markings on the inside of the lip.

Generally speaking, colours are referred to as solid or broken, the distinguishing features being the absence or presence of white spots. Solid colours are further described as hard or soft, a hard colour being one that changes very little with age or season.

When applying for registration, the applicant must be certain that the description corresponds with the colour markings. Details with respect to the following items must be included:

(a) Colour—white hairs on the body must be noted.

(b) Marks on the head—any peculiarity about the eyes must be noted.

(c) Marks on the limbs—from the feet up.

(d) Marks on the body—white spots or other marks must be noted.

(e) Remarks on the mane and tail—the presence of white hairs in the mane and tail must be listed.

1. Description of the Various Colours

(a) Black—where black pigment is general throughout the body coat, limbs and tail, with no pattern factor present other than white markings. This colour varies according to the condition of the horse, for example—a black horse in poor condition becomes "rusty".

(b) Black-brown—where the predominating colour is black, but the muzzle and sometimes the flanks are brown or tan.

(c) Brown—where there is a mixture of hairs in the body coat, some of which are black and some a light chocolate colour, with the muzzle and underline brown or tan.

(d) Brown-bay—where the predominating colour is brown, but the muzzle and underline are bay.

(e) Bay—this colour varies from a reddish brown to a light chestnut. It can be distinguished from chestnut by virtue of the fact that it is associated with a black mane and tail, and black on the legs. Horses of this colour may be bright bay, dark bay, light bay or mealy bay.

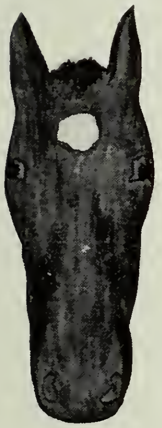
(f) Palomino—where the body is pure gold and the mane and tail are white, ivory or silver.

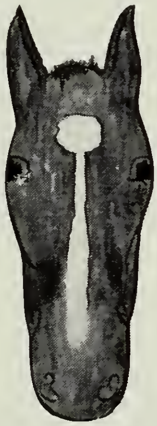
(g) Chestnut—where the body is bright, golden, or red chestnut. The mane and tail may be sorrel or chestnut.

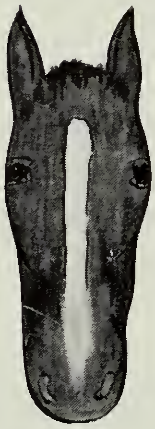
(h) Grey—this colour has many variations, all of which tend to become lighter as the horse grows older.

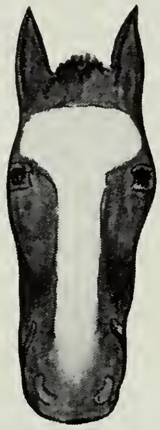
(i) Iron Grey—where the body is black or black-brown with an admixture of white hairs which gives a grey tinge to the coat. Usually the limbs are black below the hocks.

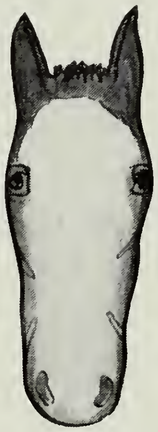
(j) Piebald—where the body coat consists of large irregular patches of black and white, with a well-defined line of demarcation between the two colours.


Star


Star & Stripe


Stripe


Blaze


White face & Muzzle

2. Description of the Colour Markings on the Limbs

(a) White Coronet—where the hair immediately above the hoof is white.

(b) White Heel—where white markings appear on the heel, that is on the back of the pastern.

(c) White Pastern—where white markings appear on other parts of the pastern.

(d) White Fetlock—where white markings appear in the region of the fetlock joints. The actual location of any of the white markings already referred to and any that appear above these points should be specifically described—for example, "white to the middle of the cannon bone," or "white to the knee or hock".

3. Description of Colour Markings on the Head

(a) Star—any white mark on the forehead. Size, shape, intensity, position and coloured markings on the white should be specified. The term "white star" is wrong.

(b) Stripe—a narrow white marking down the face, not wider than the flat anterior surface of the nasal bones. It may be a continuation of the star or distinct from it and would in the latter case be described as an "interrupted stripe" and "star and stripe conjoined" in the former. Where no star is present, the origin of the stripe should be defined. The termination of the stripe and any variation in breadth, length, direction, and coloured markings on the white should be described, e.g. "broad stripe", "narrow stripe".

(c) Blaze—a white marking covering almost the whole of the forehead between the eyes, and extending down the front of the face, involving the whole width of the nasal bones. Any variation in direction, termination, and colour markings on the white should be described.

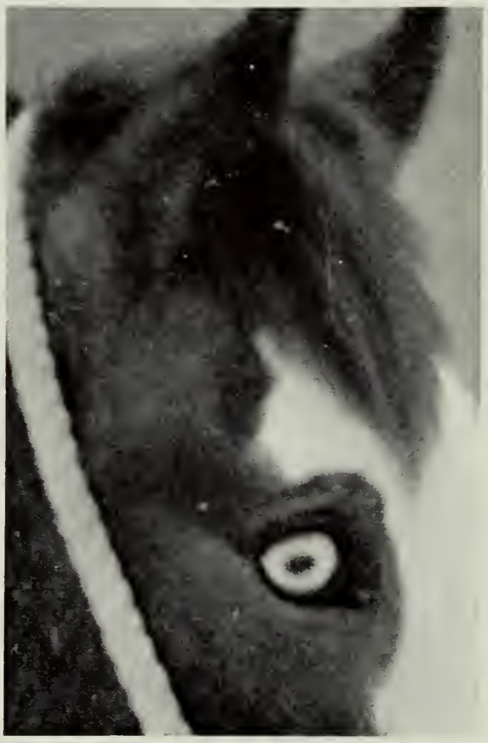
(d) White Face—where the white covers the forehead and front of the face, extending laterally towards the mouth. The extension of white may be on one or both sides, in which case it should be described accordingly.

(e) Snip—an isolated white marking; independent of those already named, and situated between, or in the region of the nostrils. Its position should be specified.

(f) Lip Markings—should be accurately described, whether covering the whole or a portion of either lip.

(g) White Muzzle—where the white covers both lips and extends to the region of the nostrils.

(h) Wall Eye—this term should be used exclusively where there is such a lack of pigment in the iris as usually to give a greyish-white or bluish-white appearance to the eye. Any other important variation from the normal colour of the iris should be noted.



A wall-eye.

GAIT TERMINOLOGY

Definitions:

(a) Gait—a term which refers to a definite way of going.

(b) Natural gaits—gaits which are performed by a horse instinctively and without training, e.g. the walk, trot, gallop, and, in some instances, the pace.

(c) Acquired gaits—gaits which result from special training, e.g. the canter, the rack, and the slow gait.

(d) Diagonal gait—a gait in which the legs move in diagonal pairs; e.g. the trot.

(e) Lateral gait—a gait in which the legs move in lateral pairs, e.g. the pace.

(f) High-gaited and High-going—are terms applied to action when a horse folds his knees, pulls his hocks, and lifts his body to a sensible height from the ground.

(g) Hard-gaited—the term applied when the stride lacks spring and when the rider's reactions to the various gaits tire him quickly.

(h) Easy-gaited—the term applied when the rider's reactions to the various gaits are pleasant and enjoyable.

(i) Free-going—a term applied when the gaits are performed in an effortless, collected manner, and action is not excessive or laboured.

(j) Labouring action—the term used when a horse moves with an obvious effort.

(k) Walk—a slow, flat-footed, four-beat gait; it is one of the most useful gaits whether in harness or under saddle if executed with snap and animation.

(l) Trot—a two-beat gait, in which the diagonal fore and hind legs act together. The rate of speed depends upon the horse. The road horse trot is a fast-stepping trot, characterized by the length and rapidity with which individual strides are accomplished, and is executed with an extreme degree of extension. The heavy harness horse trot and the Hackney pony trot are high-stepping trots and are characterized by height and spring of stride, the horse setting himself, going collectedly, and executing each step with an extreme degree of flexion and the utmost precision.

(m) Gallop—a fast, three-beat gait, in which two diagonal legs are paired, their single beat falling between the successive beats of the other two legs, the hind one of which makes the first beat of the three.

(n) Canter—a three-beat gait done under restraint. The sequence of the hoofbeats is the same as in the gallop. At the canter the weight of the horse is sustained mainly on the haunches or rear quarters, the fore-end is lightened, the chin is set, and the gait is executed in a slow, animated, collected rhythmical way on either lead at command.

(o) Pace—a rapid, two-beat gait in which the lateral fore and hind legs work together. It is characterized by the minimum of concussion, a more or less side motion (pacers are sometimes called side-wheelers), and an absence of much knee fold. It is difficult for most pacers to go in deep or heavy footing, such as fresh snow, sand, or mud, and they have a jerky, unsteady way of pulling a rig if any pull is necessary. The increased draft caused by an extra person up behind or a rough bit of road will swing most pacers into a trot. Jogging down hill may force some trotters to pace, while an upgrade often sets pacers to trotting. The pace is essentially a speed rather than a road gait.

(p) Amble—a lateral gait, usually distinguished from the pace by being slower and more broken in cadence.

(q) Rack—a fast, flashy, four-beat gait more clearly defined by the discarded name "single foot". It is seldom executed voluntarily, performed under compulsion of hand and heel. It is characterized by quite a display of knee action and speed. While very pleasant to the rider, it takes a lot out of a horse, hence should be called for with judgment and discretion.

DEFECTS AND PECULIARITIES IN WAY OF GOING

(a) Forging—striking the end of the branches or the undersurface of the shoe of a fore-foot with a toe of the hind foot.

(b) Interfering—striking the supporting leg, usually at the fetlock, with the foot of the striding leg. Frequently interference occurs between a supporting front leg and a striding front leg, or between a supporting hind leg and striding hind leg.

(c) Brushing—the term used when the interference is slight, possibly just roughing up the hair.

(d) Striking—the term used when the interference results in an open wound.

(e) Paddling—an outward deviation in the direction of the stride of a fore leg, the result of a toe-narrow or pigeon-toed standing position.

(f) Winging—exaggerated paddling, very noticeable in high-going horses.

(g) Winding—a twisting of the front leg around in front of the supporting leg as each stride is taken. This defect in gait is sometimes called threading, plaiting, or walking the rope.

(h) Scalping—or hitting the hind foot above or at the line of the hair (coronet) against the toe of a breaking-over fore-foot.

(i) Speedy-cutting—the situation occuring when a trotter or pacer at speed hits a hind leg above the scalping mark against the shoe of a breaking-over fore-foot. In trotters, legs on the same side are involved; in pacers, diagonal legs are involved.

(j) Cross-firing—a term used to describe the situation when pacers hit the inside of the near fore and off hind foot, or the reverse, in the air, as the stride of the hind leg is about completed and the stride of the foreleg is just begun.

(k) Pointing—a stride in which extension is much more marked than flexing. Pointy-strided horses break their knees very little and are low-gaited in front. Thoroughbreds, in the use of their front legs at the trot, are pointy-gaited. The term "pointing" is also used to indicate the pose assumed when a horse stands on three legs and points with the fourth; that is, when he rests or saves a leg.

(l) Dwelling—a perceptible pause in the flight of the foot, as though the stride has been completed before the foot strikes the ground. A horse may be guilty of dwelling with either his front or his rear legs. Dwelling as a defect in gait is sometimes found in heavy harness horses, heavy harness ponies, and some saddlers.

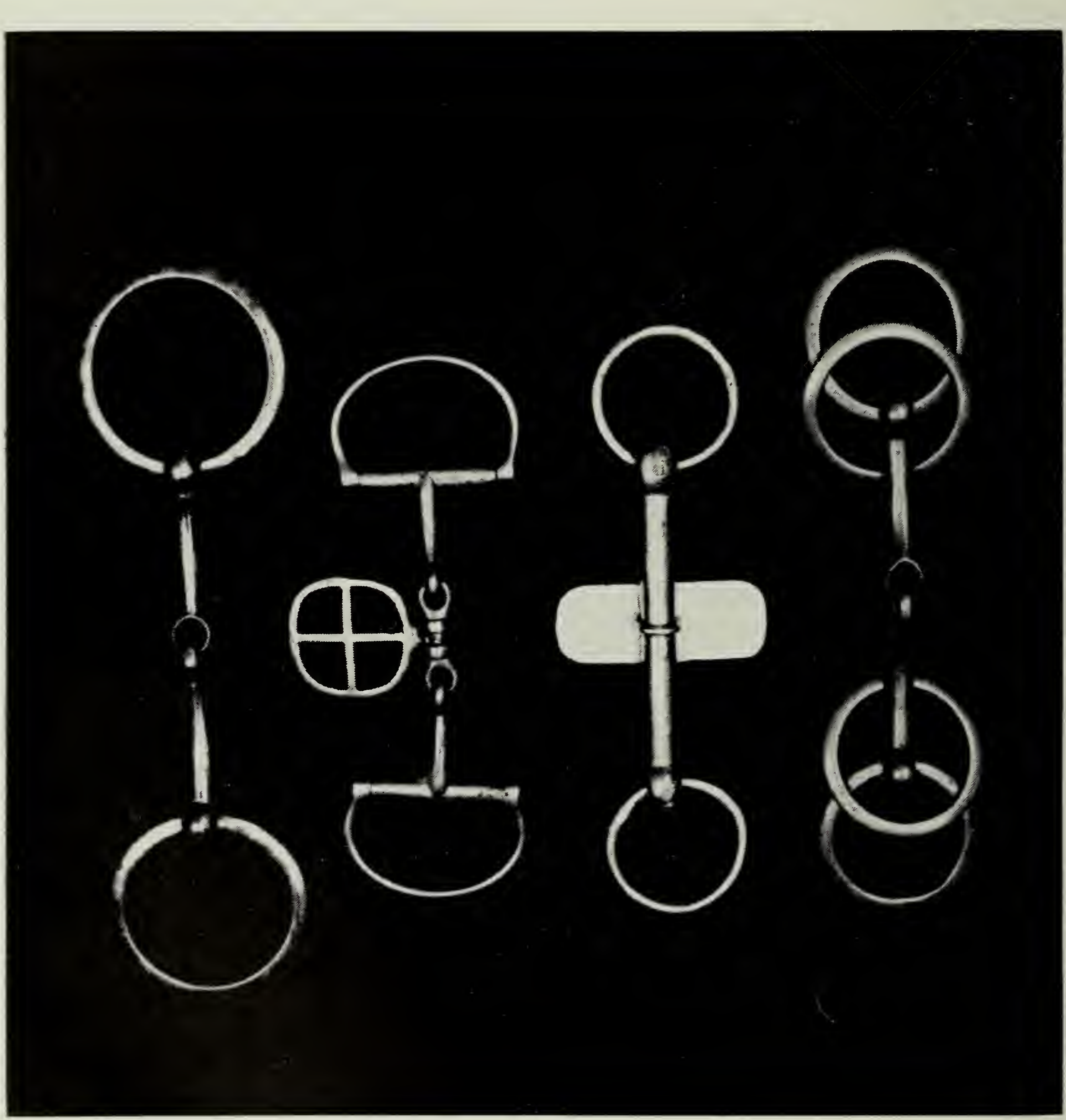
(m) Trappy—a quick, high, but comparatively short stride.

(n) Pounding—a heavy contact usually accompanying a high, labouring stride.

(o) Rolling—a defect in gait due to excessive lateral shoulder motion, characteristic of wide-fronted horses. Excessively wide-fronted drafters have the rolling-gaited tendency at the trot.

As a general rule, horses that develop into high class performers in their respective fields, receive a great deal of their training as foals and yearlings. During that stage of their lives, the trainer succeeded in establishing confidence between himself and the youngster which he was attempting to train. In all probability, the trainer's first lesson was focused on teaching the foal to come to him upon being called. When it complied he handled it gently, particularly its head and neck and its feet and legs. Eventually he taught it to lead. Throughout this initial training period, obedience was rewarded in an appropriate manner.

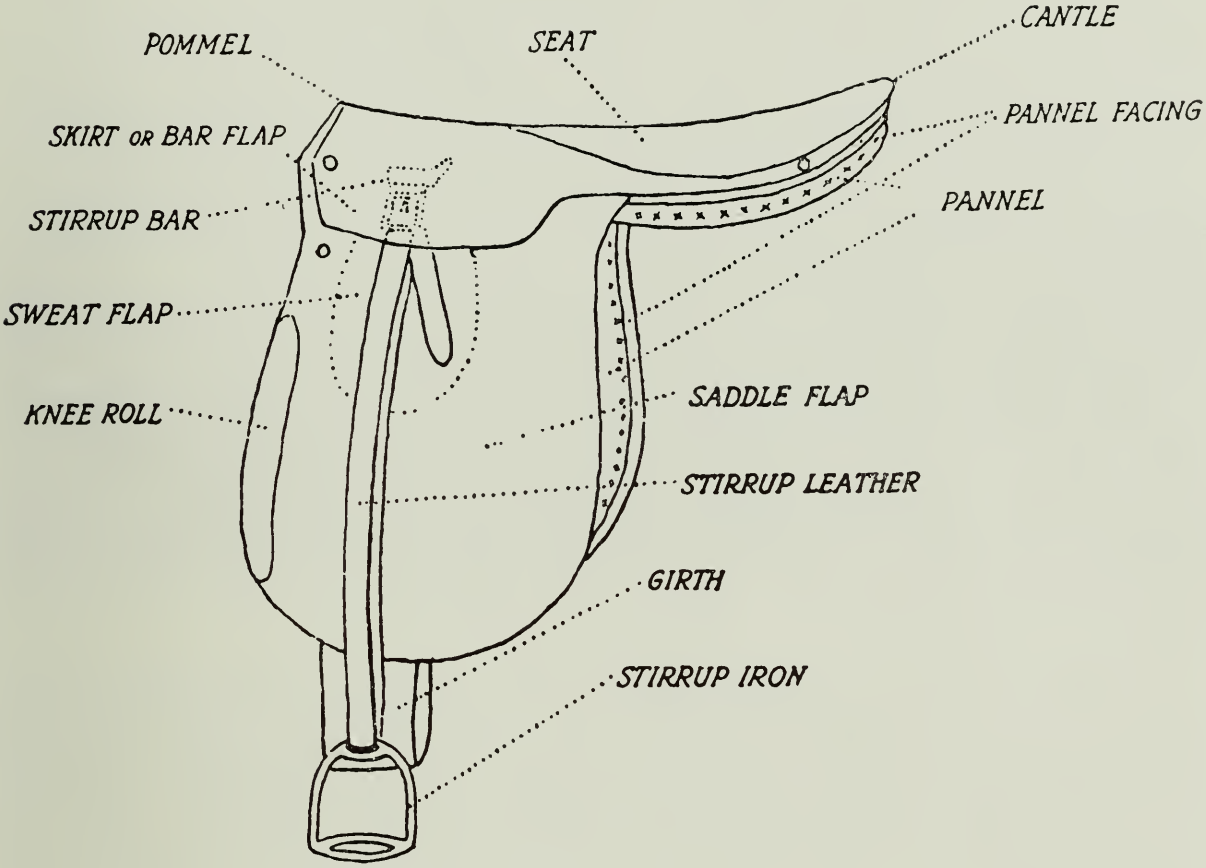
In all these steps, which are but the preliminaries to more intensive training, the trainer never forgot that a horse can acquire bad habits as well as good ones. Consequently, when leading the colt he kept a firm grip of the halter shank lest it



1. Plain jointed snaffle.
2 and 3. Types of bits used to prevent the horse from putting its tongue under the bit. No. 2 is home made and is shown bottom side up to indicate the simplicity of construction.
4. The four ring snaffle—only used in certain cases—rather severe

break loose and develop the habit of running away. On tying the colt, he fastened it securely as an insurance against the possibility of halter pulling becoming a habit.

A young horse that has been properly halter broken—that is one which has been taught to lead and also to stand when tied, will prove an apt pupil during the breaking-in period. Breaking horses to ride or drive involves a great deal of patience and skill on the part of the trainer. However, the task will be greatly facilitated if the preliminary training has been done effectively.



Parts of riding saddle.

(a) The Use of the Bit

Training the colt to become accustomed to a bit is the first step in the breaking-in process. When putting on the bridle it is advisable to slip the reins over the colt's head before removing the halter, otherwise the trainer will have no means of restraining a colt that decides to walk away. Colts that have been roughly handled often become "head shy". If each step is taken slowly and deliberately, and if obedience is rewarded with gentle strokes or pats on the head and neck, the colt will soon overcome his shyness.

As a general rule, a colt will open his mouth when he feels the pressure of a bit against his teeth. If he doesn't, the desired result can be obtained by inserting the thumb and fingers of one hand into the side of the mouth at a point between the incisors and the molars. Frequently, colts that refuse to take the bit readily become real problems. In attempting to correct this habit, it may become necessary to reward the colt with sugar, a carrot or some other tasty morsel, after the bit is in place. While bribery should not be resorted to as a means of preventing a colt from misbehaving, it is quite permissible to reward him for submitting to something which he considered to be objectionable.

The bit should lie on the bars of the mouth between the incisors and the molars. If the corners of the mouth appear to wrinkle the bit is set too high, and may produce a sore mouth or cause the horse to become a "puller"—that is one which seizes the bit between its teeth. If the bit is carried freely as a result of being properly adjusted, the horse usually responds promptly and correctly to pressure on the reins. On the other hand, horses with sore mouths or horses that are "pullers" react suddenly and not always in accordance with the intentions of the rider or driver to the slightest pull on the reins. Inasmuch as these habits and reactions were predetermined when the colt was being trained to use the bit, it is very important that it be well schooled in that regard.

A good trainer exerts pressure on the reins gently at the time of giving directional commands. When he says "whoa", "back-up" or "steady", he intends the colt to carry out those commands. However, he also indicates what he wants done by exerting the proper degree of tension on the reins. Any deviation from that routine will probably cause the colt to become confused.

(b) Learning to Ride

Inasmuch as it is difficult to learn horsemanship from a book, the beginner should take lessons from a competent instructor whenever possible. Nevertheless, some advance knowledge of terms and procedure will undoubtedly prove helpful.

When standing behind a horse, the side on the left is the near or nigh side; the one on the right is the offside. In performing any operation which necessitates moving in alongside the horse, always approach from the near side. Move quietly and deliberately, avoiding any unusual gestures that might frighten the horse or cause him to move away.

When putting on the saddle, always place it well up on the withers, then move it back to its normal position. If the procedure is reversed, thus necessitating the saddle to be moved forward, the hair will be rubbed the wrong way. This could result in chafing, a condition which will cause the horse a great deal of discomfort. The saddle girth should be pulled as tautly as possible. Since the horse will invariably swell up in order to resist the pressure being applied to his mid-section, there is little danger of the girth being pulled too taut.

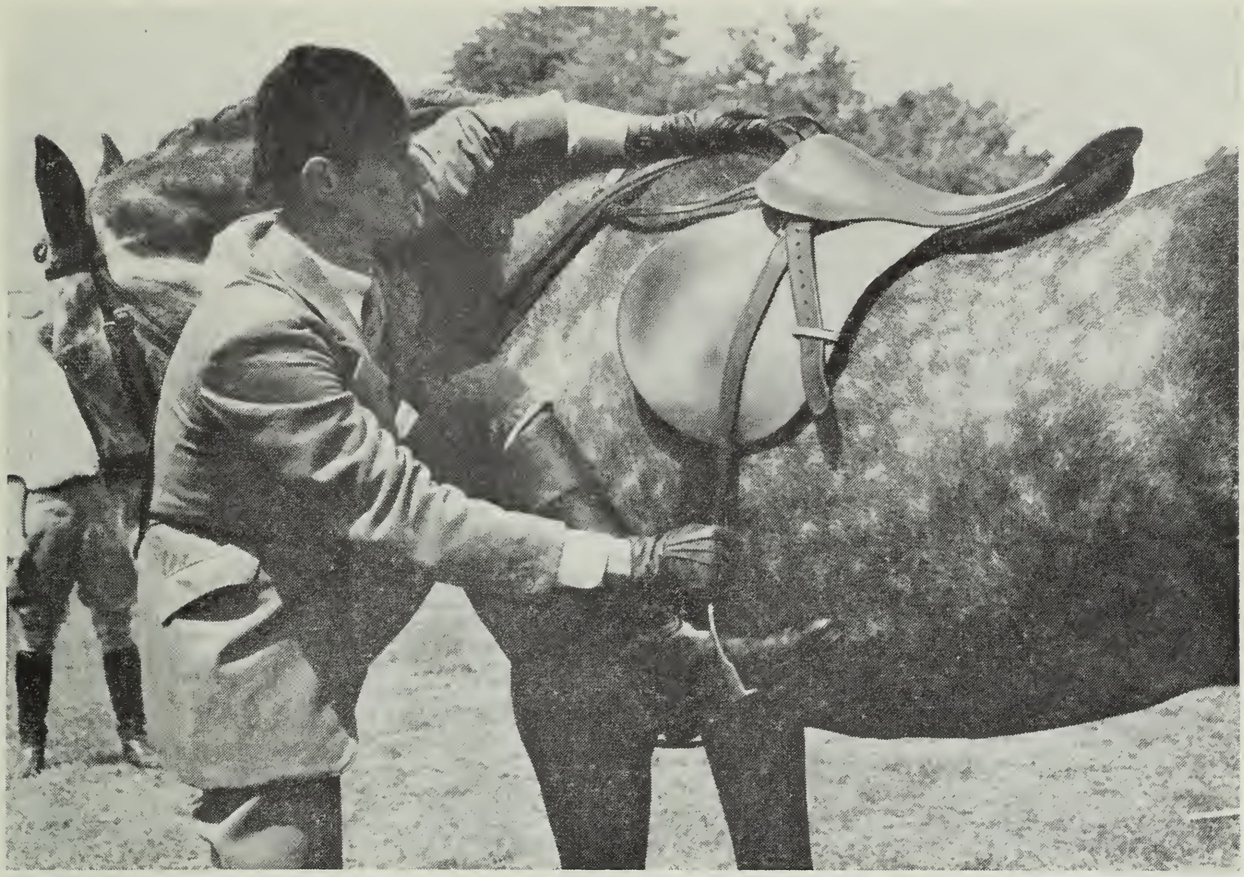
Before mounting, the stirrups should be adjusted to suit the rider. He can determine the approximate length by placing the stirrup under his armpit and extending his arm along the taut stirrup leather. If the fingertips reach the hooks to which the stirrup leathers are attached, the length is about right for him. Both stirrup leathers must be adjusted to the same length, otherwise there will be a tendency for the rider to lean to one side.

(c) Mounting and Dismounting

There are at least two recognized ways of mounting a horse:

(i) A rider may mount with his back to the horse's head and facing its rear quarters. This position is preferred by many, because the rider is carried into the saddle if the horse moves forward while he is mounting.

(ii) A rider may face the side of the horse. This position is considered correct, especially for mounting certain types of well-broken horses, for example—saddle horses that have been trained to stand with their fore and hind legs spread well apart, hence are unlikely to move forward while the rider is attempting to mount.

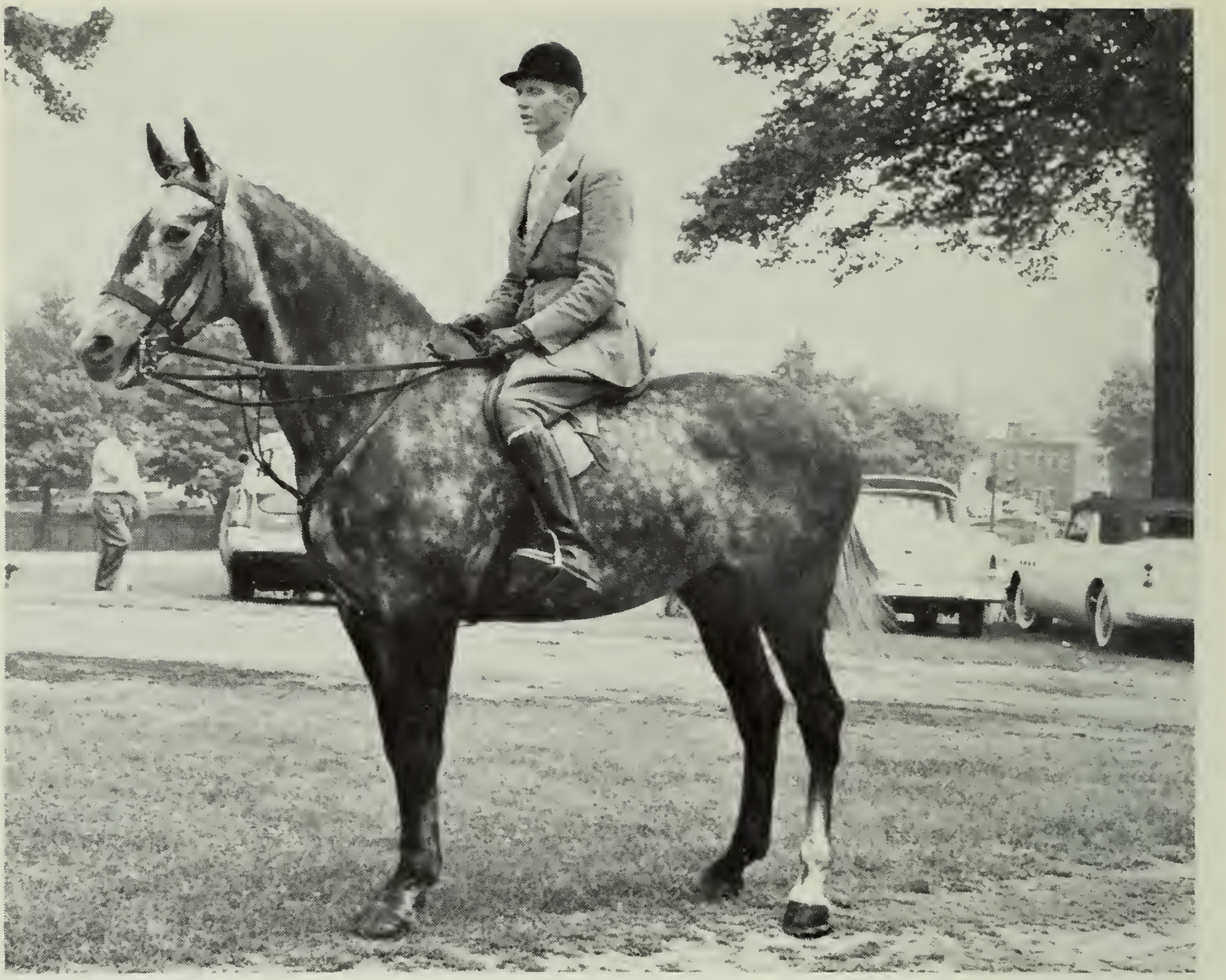


Correct Hand Grip.

In preparing to mount, the rider should place one rein on each side of the horse's neck; then gather them in his left hand, which at this time should be directly in front of the saddle. Next, he takes up the slack in the reins and grasps some of the mane along with them. The right hand is placed on the pommell or cantle of the saddle—whichever provides the most natural place to clutch. Then, the left foot is placed into the stirrup; by springing from the right foot the rider should be able to swing himself into the saddle. The first attempts may not be perfect examples of precision, but with practice, even the novice may become quite proficient. Regardless of the method employed, the rider must get into the saddle without hitting the horse's back with his full weight.

In dismounting it is a common practice to reverse the procedure followed in mounting. Hence the rider grasps the reins in his left hand and places it firmly on the withers. Then, he slips his right foot out of the stirrup-iron and passes it over the saddle. While doing so, he is careful to avoid touching the horse's back with his right leg. The toe of the left foot is kept in the stirrup-iron until the right foot has almost reached the ground at which time it is withdrawn, thereby enabling the rider to drop lightly.

This procedure incurs the danger of the left foot being caught in the stirrup-iron, particularly if the horse becomes startled. However, if only the toe is left in the stirrup-iron the danger is reduced to a minimum.



A rider sitting in saddle.

(d) Position in the Saddle

The term "good seat" is used to describe the correct position of a rider in the saddle. Such a position is essential to a pleasant ride. In order to acquire a "good seat" the rider must sit loosely in the saddle, maintain his position by means of balance and learn to follow the movements of the horse.

Of these three requisites, balance must be acquired first. Since the greater part of a rider's weight is above the saddle, pressure exerted by the limbs is not likely to save him from falling if his torso is off balance. Although legs and arms have nothing to do with balance they can be helpful to a rider who has lost his balance. Balance, when associated with riding a horse, must be learned in somewhat the same way as a boy learns to steer a bicycle without the aid of handle bars.

Looseness refers to the degree of relaxation assumed by the rider. Although a good rider is fairly relaxed, he does not allow his arms and legs to flop about. Rather, he must consciously control the movement of his limbs at all times. As soon as he has acquired the proper feeling of balance all semblance of stiffness and rigidity is likely to disappear.

Nevertheless, he must be able to use his legs effectively in cases of emergency. The inside of the knee joints, the lower part of the thighs and the upper part of the calves are used to grip the horse in the event that it makes some sudden or unnatural movement. The lower part of the leg should not be used for this purpose as this will bring the rider's heels in contact with the horse's body, a contact that should never be made except in conjunction with a directional command.

A rider should learn to balance himself and to relax before attempting to move his horse at any gait faster than a walk. When the horse begins to trot he will probably fight against the bumping action, by clinging to it with his legs and thighs. If so, he will soon discover that his limb muscles are stiff and sore, and he may also experience a feeling of being left behind. In order to overcome that feeling he should lean slightly forward so that the lower end of the spine rests firmly in the saddle. This makes for closer contact between the rider and the horse and eliminates the discomfort created as a result of the thighs and legs being pressed against the horse's girth. The art of following the horse is mastered when the rider does not bump constantly in the saddle as the horse moves at some gait other than a walk.

(e) The Use of Aids

Any action taken by the rider to improve the performance of his horse is referred to as an "aid". A rider can exert influence with his legs, his back, his weight and the reins. The legs are used in causing the horse to move forward, the reins in restraining, the weight and the reins to indicate the direction towards which it is expected to proceed, and the back muscles to enable the rider to move in harmony with the horse.

When the rider wishes his horse to move forward, he presses his heels against its girth. If the balls of the feet are resting on the stirrups—and that is the proper position for them, the ankles will have complete flexibility; hence no difficulty should be experienced in applying this "aid". The degree of pressure will vary with the gait desired. For example, only a slight pressure is required if the rider wants the horse to walk. However, greater pressure is used to induce more rapid gaits.

Every body has a centre of gravity, which in turn changes its position when the body moves. In riding, the centre of gravity of the rider should be directly above that of the horse. Since the focal points of both are constantly changing when the horse is in motion, the rider must at all times strive to adjust his centre of gravity into a correct position with respect to that of his mount. If he is successful in doing this the horse will carry his weight with greater ease, while the horse, relieved of the excess weight which it might otherwise be carrying, will be able to give a much better performance..

Although the reins function primarily in restraining the horse, they are also used to indicate direction. When the rider wishes his mount to walk he should shorten the reins just enough to create a slight pressure on the mouth. If a faster gait is desired the pressure on the mouth should be increased. In either case pressure exerted by the heels upon the girth must coincide with that applied to the mouth.

On occasions it may be necessary to ride with the reins in one hand; however, it is better practice to use both hands. When the reins are held in this way the rider is more likely to hold his body erect and at right angles to the backbone of the horse.

(f) Disobedience

Although a horse may not always obey its rider it never misbehaves out of sheer meanness. Disobedience often manifests itself in trivialities which go unheeded by the rider. In many instances his actions are responsible for these bad habits. For example, leaning on the bit is generally caused by a heavy hand on the part of the the rider. If the horse has acquired this habit, a few short but decisive taps with the whip, close behind the girth may prove effective in correcting it. Punishment should be repeated until the habit is broken.

When shying, a horse always stares at the object which has frightened him. Consequently, he must be headed in the other direction and driven well forward until he has passed the source of his fear. If the horse refuses to budge, the rider should dismount and lead it past the object.

A horse can only rear when standing still. Hence, to overcome the condition, every effort should be made to cause a rearing horse to move forward. When a horse rears suddenly, the rider is well advised to grab the mane, and hang on, in order to save himself from being toppled over backwards. He should never pull on the reins as this action tends to incite its desire to rear.

(g) Driving Heavy Harness Horses

As a general rule, the driver should hold the reins in his left hand, his right hand being free to take up the slack or to hold the whip. Usually the near rein is held between the thumb and forefinger, the off rein between the middle and ring fingers. When held in this manner, the two reins will be separated by two fingers. This allows for sufficient space to permit the fingers of the right hand to be inserted quickly in the event that it becomes necessary to shorten the hold on the reins. This is done by dropping the thumb and forefinger of the right hand over the near rein, while slipping the remaining three fingers between the two reins at such distance in front of the left hand as may be required to take up the slack. The reins should be gripped by their edges rather than their flat sides.

In case a driver wants to turn he may indicate the direction towards which he wants the horse to proceed by exerting pressure on the appropriate rein with his right hand. If a two-handed grip is required, the off rein may be released by the left hand so that it will pass through the right hand and over the thumb.

With respect to position, the left hand should be held so that the knuckles are pointed forward and perpendicular; the forearm horizontal and almost at right angles to the reins. This position ensures the greatest freedom of the wrist and fingers, is conducive to a light hand and renders a continuous dragging pull almost impossible.

HOUSING AND EQUIPMENT

Occasionally it becomes necessary to remodel a horse barn or build a new one. The first consideration should be the comfort and security of the horse, then the convenience of the attendant. The sound basic principles used in planning larger stables may be applied to the quarters of the one or two-horse stable.

The following points should be considered:

1. Width
2. Ceiling height
3. Windows
4. Alleys
5. Standing Stalls
6. Floors
7. Stall construction
8. Box stalls
9. Doors
10. Harness room or Tack room.
11. Paddocks
12. Water
13. Bedding

1. Width—one row of stalls requires twenty feet or more for alley, stall, manger and walk.

2. Ceiling Height—the distance from the floor to the under side of the ceiling joists should be at least 8 feet; $8\frac{1}{2}$ or 9 feet is preferable. Low ceilings are usually associated with dark, stuffy stables, and there is some danger of injury to stock. Provide at least 800 cubic feet or more air space per horse. A tight ceiling is always preferable.

3. Window space—in as far as possible the windows should be at the rear of the horses, and there should be about five square feet per horse.

4. Alleys—feed alleys should be made at least 3 or 4 feet wide. The litter alleys at the wall should be 7 feet wide or more.

5. Standing stalls—the standing stalls for work animals may be single or double. If space permits, it is better to have single stalls. A single stall for a draft horse should be 5 feet wide from centre to centre of partition and at least 9 feet in over-all length. The top of the manger should be 2 feet wide and the standing platform 7 feet long. *The standing stall should be wide enough for a horse to lie down in comfort but not wide enough to encourage him to roll.* Therefore, the size of stall will vary according to the type of horse.

6. Floors—the most satisfactory floor for the standing stall is concrete with the standing stalls overlaid with 2″ plank. The stall floor is sloped 1″ in its length toward the gutter. The gutter should consist of a slight depression rather than a distinct gutter.

Drainage may also be secured by making a gutter 8 inches deep and 6 inches wide and covering it loosely with a plank set flush with the floor.

The manger is built to a height of 4 feet on alley side and $3\frac{1}{2}$ feet on stall side. The manger should be about 2 feet wide at the top and 12 inches at the bottom, the whole manger being 12 inches from the floor. A slatted bottom allows dirt and chaff to drop in the stall floor.

7. Stall construction—in horse stable construction everything should be solid and permanent. Box stall partitions should be made tight to a height of about 4 feet; above this there should be a guard about 3 feet high at the front of the stall partitions. The partitions between the stalls should be solid or nearly so to ceiling height.

8. Box stalls—a box stall should be provided regardless of the number of horses kept. It is essential for sick animals, colts, or mares at foaling time, and should be at least 12′ x 14′. The box stall should have a feed box and manger of a type that takes us as little room as possible and with no projecting corners. Dirt or clay floors are preferable.

9. Doors—the box stall door should be 3½ to 4 feet, ample width for a horse to be led in and out without danger of bumping. Sliding doors are more satisfactory than hinged doors because they never protrude into the alley. Hinged doors which may be more easily and cheaply installed in the small barn are perfectly satisfactory if kept closed when horses pass through the aisle.

If there is a door to the rear of the stall or one that opens outside or to the paddock, it is advantageous to have this a "Dutch" door. The upper half alone can then be opened for light and air. Sometimes a bar must be added above the lower door to keep an active horse from jumping out.

Wood, concrete and steel are used in stall construction. Wood, the most common material used, should be of 2″ plank, such as rock elm or any other tough timber. Supporting posts should be 6″ x 6″ of any durable wood.

10. Harness room or Tack room—the harness room should be large enough to accommodate the equipment, harness and saddles.

11. Paddocks—if large pastures are not available grass paddocks of one or two acres will prove very valuable. A large paddock provides exercise, fresh air and grass. When turning a horse loose into a field, the man leading the horse should turn its head towards the gate while removing the headstall or halter, after which he should stand clear, since horses often kick as soon as they find themselves free. Horses should not be turned out in mid-day heat of summer unless there are shade trees in the paddock. Theoretically it would be advantageous to remove the manure dropped on the paddocks at regular intervals because this action would lessen the danger of flies and other parasites. Practically this may not be possible; however, the paddocks should be harrowed at frequent intervals to spread the manure, thereby disturbing the site where parasites breed and multiply. Weeds such as catnip and plantain should not be allowed to grow in the paddock.

12. Water—the method of watering horses matters very little. It is more important that some satisfactory method be followed. No matter whether water is kept in the stall or whether the horse is watered at intervals from a trough in the barn or tank by the well in the yard, the water container should be kept clean.

Automatic watering bowls placed in a corner of box stalls are a great convenience and assure the horse of a regular supply of fresh water. A horse should be cool enough when he reaches the stable to either eat or drink. If no feed has been put in the manger he will usually drink.

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HOUSE PLANTS and GIFT PLANTS

ONTARIO DEPARTMENT OF AGRICULTURE

PARLIAMENT BUILDINGS, TORONTO, CANADA

CONTENTS

Page
Introduction 3
Light 3
Temperature 3
Atmosphere 4
Soil 4
Potting and Repotting 5
Watering 6
Fertilizer 7
Insects and Other Pests 7
Abutilon, Flowering Maple 8
Achimenes, Cupid's Bower 8
Agapanthus, Lily of the Nile 9
Amaryllis, Eastern Star 9
Anemone, Poppy Anemone 9
Ardisia 10
Artillery Plant 10
Asparagus 11
Aspidistra 11
Astilbe 11
Begonia 11
Bracketplant 13
Bromeliads 13
Browallia 14
Bulbs 15
Cacti and Other Succulents 16
Calceolaria, Slipperplant 19
Caladium 20
Calla 20
Campanula, Italian Bellflower 20
Carnation 21
Christmas Cherry 21
Chrysanthemum 21
Cineraria 21
Clivia 22
Colchicum 22
Coleus 22
Croton 23
Cyclamen 23
Dracaena and Cordyline 24
Elodea 24
Ferns 24

Page
Freesia 26
Fuchsia 27
Genista 27
Geranium 28
Gloxinia 30
Gynura 30
Helxine, Baby's Tears 31
Hibiscus 31
Hydrangea 32
Hymenocallis, Spiderlily 32
Impatiens 33
Ivy 33
Kohleria 34
Lantana 34
Leopard Plant 35
Lily 35
Lily of the Valley 36
Maranta, Arrowroot 36
Nephthytis 36
Norfolk Island Pine 36
Oleander 37
Oxalis 37
Palms 37
Parsley 38
Peperomia 38
Periwinkle 39
Petunia 39
Philodendron 40
Poinsettia 40
Primrose, Primula 40
Ranunculus 41
Rubber Plant 41
Ruellia 41
Saintpaulia, African Violet 41
Sansevieria 42
Screw Pine 42
Silk Oak 43
Sweetpotato 43
Umbrella Plant 43
Wandering Jew 43
Wax Plant 43

HOUSE PLANTS AND GIFT PLANTS

by
H. BAILEY
and
J. S. SHOEMAKER

Department of Horticulture, Ontario Agricultural College,
Guelph, Ontario

INTRODUCTION

The culture of plants in the home provides an interesting and challenging hobby. Since the furniture and other objects in a home are inanimate, life is provided by having plants in a room, and thus an effective feature is added to the decoration scheme. A wide range of plants is suitable for growing in the home. But, as might be expected, different cultural procedures are needed for best results with different kinds of plants.

Because both house plants and gift plants are discussed in this publication, it is pertinent to explain the difference between them. Generally speaking, a house plant is one that is adaptable to home conditions and is grown through most of its stages indoors. A gift plant, such as cyclamen, poinsettia, and azalea, is generally more specific in its requirements. It is propagated and grown for some time in a greenhouse and is sold, usually in full bloom, by commercial florists to give an immediate effect at certain seasons and for special occasions.

LIGHT

In winter when the daylight period is short, place the plants, especially the kinds that require as much sunlight as possible, in the brightest locations in the house. In the long days of spring and summer, however, when the sun is very bright, the temperature in direct sunlight just inside a window is often so high that the plants may need to be shaded during part of the day by drawing curtains or placing cardboard or paper between the plants and the window. Moving the plants to a window with less direct sunlight in summer is often a good practice. When grown in windows, plants tend to become one-sided. This may be prevented by giving them a quarter turn each day.

Certain plants will tolerate more shade than others. Comments on light requirements are made later for particular kinds of plants.

TEMPERATURE

Most plants thrive at a day temperature of 65°F. and a night temperature of 55° to 60°F. Since house temperatures are often too high, it is best to grow the plants in the cooler parts of the room, usually near a window. Drafts should be avoided. Blinds or drapes when drawn should come between the plants and the window, and thus prevent the plants from being in a cold air space.

During very cold weather, it may be wise to place a piece of corrugated cardboard between the plants and the window. Plants may be injured beyond recovery by cold, but often, if placed in a cool cellar and sprinkled with cool water, slightly injured plants can be thawed out with little or no damage, cut back to a good bud, and grown afresh.

ATMOSPHERE

Dry atmosphere is often one of the chief factors responsible for the failure in growing house plants. Dryness and heat favour red spider, thrips, and fern scale. Water should be kept in a vaporizing pan in the furnace, on radiators, or in hot-air registers. Modern humidifiers or air conditioners improve the moisture content of the air.

SOIL

A good soil for house plants should be a mixture that contains lasting fertility, has a suitable structure so that both water and air can permeate reasonably well, is retentive of moisture, is free from weeds, insects, and diseases, and possesses a suitable soil reaction depending upon the requirements of the species.

Compost soil is usually best for a potting mixture for house plants. Sod is cut 4 or 5 inches thick from a clean pasture or lawn and placed face down in layers to make a pile, and left for at least a year to decay. If the pile is turned once or twice during the summer, the decay is accelerated. Instead of adding well-rotted manure when compost is ready to use, it may be added in layers when the pile is being built.

Many persons simply use a good garden soil for their indoor plants, and the plants often thrive in such a soil at first; later, however, certain adverse conditions may appear that can be traced to the soil that was used. A better potting mixture may be prepared with a little extra work.

A good general mixture may be made from 7 parts of compost or good garden soil, 2 parts of organic matter such as well-rotted leafmold or peat, 1 part of well-rotted manure, and 2 parts of building sand. It is often wise to add about a 4-inch pot of superphosphate to each wheelbarrow load (2½ bushels) of soil. Mix these ingredients thoroughly before the soil is used. If the soil used is low in fertility, add a complete fertilizer, such as 5-10-13, at the rate of half a 4-inch pot of fertilizer plus half a 4-inch pot of superphosphate.

For best results, the soil mixture should be "sterilized" before the fertilizer is added. The greenhouse operator usually sterilizes with steam, but small lots of soil may be sterilized in the oven, or over a wood fire outdoors, or by pouring boiling water through the soil. In the oven method, place a pan of moist soil in the oven and heat it to 200°F. for at least a ½ hour. In the outdoor method, place soil about 6 inches deep on a sheet of metal over a fire and stir frequently so that the bottom layer does not burn. In the hot-water method, pour enough boiling water through the soil to heat it to 170° to 200°F.; the soil must drain and dry to the right moisture content before it is used. All soils when ready for potting should be just moist enough to hold together when squeezed tightly.

Cyclamen, Hyacinth, Ranunculus, Primrose, Impatiens

The optimum soil mixture varies with different kinds of plants. The best soil for a certain plant may be prepared by adding to the general mixture more sand or more organic matter, or by using additional fertilizer, as indicated more specifically later.

POTTING AND REPOTTING

Poor drainage is a frequent cause of failure with house plants. With small pots, drainage is supplied by placing coarse peat or moss in the bottom of the pot. With larger pots and those in which the plants will remain for some time, place pieces of broken flower pots, concave side down, as well as some roughage, over the drainage opening.

In potting seedlings or rooted cuttings, the soil should be finer than for older plants and should be fairly low in nitrogen. Place drainage material in the bottom of the pot and add enough soil so that, when the young plant is placed in the pot, it is about the same depth as in the seedling flat. Add soil, then tap the bottom of the pot on the bench and, at the same time, press down the soil with the fingers to settle it firmly about the young plant. Then level the soil, leaving enough space at the top of the pot for watering.

Repotting

Repotting is required: (1) when the plant is too large for its present container and has become pot-bound; (2) when the soil has become exhausted; (3) when the soil is "sour" and the plant is unhealthy. Although repotting should be done whenever necessary, the best time is in spring.

When shifting a plant to a larger pot, use coarser and richer soil than for seedlings or cuttings. Dump the plant out of its old pot by turning the pot upside down and tapping the rim of the pot on the edge of the bench, keeping the fingers over the soil to prevent the plant from falling. Remove the old drainage pieces and discard some of the old soil from the top of the pot; then add soil on all sides of the plant, firming the soil with the fingers or a narrow slat of wood, and by tapping the pot on the bench.

An unthrifty plant is often caused by a waterlogged soil. In this case, a good procedure is to take the plant from the pot and remove as much soil as possible by shaking and washing in water. Repot the plant in a pot just large enough to hold the root system nicely, using a soil low in nutrients and with considerable sand. Apply water carefully until the plant has recovered; then repot in a better soil.

Tall, straggly specimens may be cut back to within 3 to 4 inches of the soil, and then treated as previously described. After this treatment, the plant, having no foliage, requires little watering until new growth has been established.

WATERING

Lack of water results in a check in growth, shedding of leaves, and unsightly plants with dull unattractive foliage. Too much water results in a lack of oxygen in the soil, and so causes the roots to rot.

The problem of when to water cannot be answered by simply saying "daily" or "once a week". The temperature, the humidity, and the light in the room must be considered, as well as the type of plant, the kind of plant, the kind of soil, the age of the plant, the rate of growth, and the size and type of container used. In general, the soil should be kept just moist at all times.

The condition of the surface soil usually indicates when water is required. Other aids include tapping the side of the pot. A dry pot emits a clear ringing note, whereas a dull sound is produced by a wet pot. The difference in weight between a dry pot and a wet one can be noted merely by lifting them.

When watering, add sufficient water to wet the soil to the bottom of the pot and then do not water again until the plant or soil shows signs of needing it. If the plant is growing rapidly and is in a warm, sunny position, watering may be required daily. But if the plant is in a cool location with no direct sunlight and is making little growth it may not need watering more than once a week. Watering should be done early in the day so that the plants are not saturated over night.

Plants are generally watered by filling the space left at the top of the pot for this purpose. In doing so, care should be taken to avoid wetting the foliage, especially if the foliage is heavily pubescent (hairy).

Certain water softeners, in removing calcium from hard water, replace this calcium with sodium. The sodium may be injurious to house plants, and when such is the case a special effort should be made to obtain rain water or melted snow.

Plants may be watered by placing the pot in a shallow pan of water until the top surface of the soil is moist. This method, if used continually, tends to result in a crystalline deposit on top of the soil, which may become toxic to the plant. To avoid this condition, water the plant from the top every 2 weeks. Azaleas and hydrangeas, when full grown, often need to be placed in deep water for about 20 minutes at a time to ensure the soil being well watered. Cold water direct from the tap is harmful to some house plants. In such cases it is wise to warm it slightly to avoid chilling effects.

FERTILIZER

Fertilizers such as a 5-10-13 and superphosphate are applied when the soil is being mixed for potting. When used later it is difficult to mix them with the soil and they may remain on the surface, slowly soluble and often unsightly. Plants should be fed only when they are well established, and when the soil in the pot is moist. If some of the fertilizer gets on the foliage, it should be washed off to prevent risk of burning.

The required nutrients may be applied in liquid form. Potassium sulphate, potassium chloride, sodium nitrate, and ammonium sulphate are used at the rate of 1 ounce to 2 gallons of water; ammonium nitrate, 1 ounce to 5 gallons of water. Trade-name liquid or soluble crystal forms should be used as directed on the containers.

INSECTS AND OTHER PESTS

Sooner or later some plants in your home may become infested with one of the many pests that attack plants. When possible, move the infested plant away from the clean ones, identify the pest, and use the recommended control.

Scales are small insects that fasten themselves to a plant and then remain stationary. They are flat, oval or circular, and covered with a hard, smooth coating. They are usually brown or black on house plants, with the exception of the small, white, fern scale. The brown and black scales may be removed from plants with smooth foliage, such as aspidistra and palms, by washing with soapy water to which may be added nicotine sulphate or rotenone at the rate of a teaspoonful to a quart of water. During the washing, the scale must be moved to be killed. The white fern scale is very difficult to control as the nature of the fern's fronds prohibits vigorous washing. If possible, remove infested fronds, and move the fern to a location with higher humidity.

Aphids (plant lice or green fly) are soft-bodied insects usually of a green to black color. They obtain their food by piercing the plant and sucking the juices. Dipping the plants in a solution of 2 tablespoonfuls of nicotine sulphate to 3 gallons of sudsy water, or spraying with this solution, will control this pest. Certain rotenone insecticides also will control aphids.

Red spiders are very small (much smaller than a pin head) and flourish in a hot, dry atmosphere. For control, spray with 2 tablespoonfuls of rotenone to 3 gallons of water, or use Aramite as directed on the package.

Mealy bugs are soft-bodied, slow-moving insects that are covered with fluffy white material which gives them a mealy appearance. A good control measure in homes is to touch the mealy bugs with a water-color paint brush dipped in 50 per cent denatured alcohol.

White flies are tiny and white. When an infested plant is disturbed, the adults fly about. For control in the home, dip or spray the plants, using 50 per cent DDT powder at the rate of 1 ounce to 5 gallons of water. The residue of this spray will also kill the eggs of the white fly as they hatch. Repeat the spray in 3 weeks. Be sure the DDT powder is designed for spraying plants, because some DDT sprays, such as barn sprays, are injurious to plants. DDT in any form is injurious to Kalanchoe plants.

Worms, especially garden worms, may become quite a nuisance in pot plants. Also, manure used in a potting mixture may contain eggs or larvae that later will become flies. Sterilizing the soil mixture before using it destroys these pests.

Springtails and **symphylids** are small white insects that commonly occur in soils high in organic matter. The former hop on the surface of the soil, feed only on decayed organic matter, and cause little or no damage to plants. The latter dart in the soil when disturbed, feed on plant roots, and therefore are destructive. To control both of these insects, apply lindane to the soil at manufacturer's directions.

ABUTILON

Flowering Maple

The abutilon (*Abutilon hybridum*) is a native of warm regions and does best in temperatures of 55° to 65°F. This shrubby plant, with maple-shaped foliage, has either green or variegated leaves and drooping bell-shaped flowers that are yellow, pink, white, or striped in colour. Indoors, its use is limited to the sun porch or conservatory because of its rapid growth and large size. Good light is essential. It will not tolerate a dry atmosphere.

Abutilon is propagated by either cuttings or seed. Make the cuttings directly from the flower beds in the fall or in the spring from plants wintered indoors. The variegated-foliage type must be propagated by cuttings to maintain the variegation.

The best soil for the plants is a mixture of equal parts of loam and sand plus a little organic matter such as leafmould or peat. To produce a bushy plant, top the plants while they are young. If a standard is desired, prevent branching until a height of 4 to 6 feet is attained. Then pinch off the top to promote branching, and also pinch, several times, the tips of the branches that arise. Large plants in large containers may be wintered in the cellar, with just enough water supplied to prevent severe wilting.

ACHIMENES

Cupid's Bower

Many beautiful hybrids of Cupid's bower can be grown as house plants. They have petunia-shaped flowers in shades of scarlet, rose, and blue. They are usually started from small scaly tubers. In the spring, plant 5 to 10 tubers in a 5- to 7-inch pan.

A suitable soil mixture is 3 parts loam, 3 parts organic matter such as leafmould or peat, and 1 part sand. Put the pans in a warm place, and keep the soil just moist until growth starts. Shade the plants from bright sun. When the buds show, feed the plants weekly with a dilute liquid plant food.

After flowering, keep the plants watered until the foliage starts to turn yellow. Then, withhold water and rest the plants. Keep the dry pots of plants at about 55°F. In the spring, separate the flowering-size tubers from the smaller ones and plant them for flowering. The smaller tubers may be planted thickly and grown to produce flowering-size tubers for the following spring. Achimenes may also be grown from cuttings taken in June. For growing from seed, treat as suggested later for Tuberous Begonias.

AGAPANTHUS

Lily of the Nile

Lily of the Nile does best in a large pot or tub, hence its use as a house plant is limited. The roots are thick and fleshy, the foliage is strap shaped, and the clusters of lavender, blue, or white flowers are borne on tall flowerstalks. Water the plant freely during growth, but reduce the moisture supply after bloom. During the rest period the plant keeps on growing a little, and therefore do not allow it to dry out excessively or place it in complete darkness.

AMARYLLIS

Eastern Star or Knight's Star

Amaryllis takes 2 to 4 years to flower from offsets, and much longer from seed (it does not come true from seed). Buy large bulbs in the fall and place in 5- to 7-inch pots, one to a pot, covering only the thickest part of the bulb and thus leaving about two-thirds above the soil. The soil should be fertile and contain some leafmould. Repot about every three years, after bloom or after a rest period.

Amaryllis may be grown by two methods: 1. *With a rest period.* After the plant has flowered and produced its leaves, feed it with a complete soluble plant food weekly for 6 to 8 weeks to strengthen the bulb. Then gradually dry it off and rest it until the foliage is dead. To renew growth, place the plant in good light and apply just enough water to start growth. With this method the plants bloom more evenly, and often flower before producing leaves. 2. *Continuous growth method.* Keep the plants growing instead of giving a rest. Feed them every 2 or 3 weeks. They will flower at any time of the year, and sometimes will flower twice in the same year.

ANEMONE

Poppy Anemone

The anemone (*A. coronaria*) is usually propagated by division, but it may also be started from seed sown in the spring. For flowering in February or March, plant about six tuberous roots, in September or October, in a 6-inch pot of light soil and keep at 50°F. in a dark place until the tip growth starts. Then move to partial light, eventually allowing full light a few days before flowering. Keep the soil just moist, with no overwatering, until the plants bloom; then increase the amount of water applied. These plants do best when pot-bound. After bloom, gradually dry off the plants. Then clean and store the tubers in a cool place until the next fall when they may be grown again.

Artillery Plants

ARDISIA

This shrubby, red-berried plant (*A. crenata*) is attractive at Christmas. When propagated by cuttings of the half-ripe wood in April or May, it roots best if a bottom heat of 70°F. and an air temperature of 65°F. are maintained. It may also be rooted by aerial layering. If grown from seed, the plants are variable and leggy. It does best in a cool, sunny position. For larger plants, carry over the specimens to the next year.

ARTILLERY PLANT

The artillery plant (*Pilea microphylla*) is so called because the minute flowers open suddenly with puffs of pollen like the puffs of smoke from artillery. The opening of the flowers is brought about by supplying warm moist heat, such as a light syringing in a warm location or by cupping the hands around a leaf and breathing on it. It is grown mainly for its fern-like appearance, is easily propagated by cuttings, and thrives in a light soil that is well supplied with organic matter such as leafmould or peat.

ASPARAGUS

Asparagus plumosus and *Asparagus sprengeri* are the species more commonly grown as house plants. These plants are often wrongly called asparagus "fern". They produce seed; ferns produce only spores. *A. plumosus* has fine lace-like plumes of foliage and is a climber; its dwarf form (var. *nana*) does not climb. *A. sprengeri* is a climber. It has lighter green and much coarser foliage than the plumosus type. Both species are good for hanging pots, in window boxes, and as specimens.

They may be propagated by division, but are usually grown from seed or bought as small plants from the florist. Seed sown in the spring, after soaking for 24 hours in water, germinates in 30 to 50 days. Plant the seedlings in a rich, light soil, and in a temperature of 60°F. with good light. In the summer, supply established plants with nitrogen, such as ammonium sulfate (1 ounce to 2 gallons of water), every two weeks.

ASPIDISTRA

Aspidistra (*A. elatio*r) is an evergreen perennial. It is often called the Cast Iron Plant because of its ability to tolerate poor light and a dry atmosphere. It thrives better in good light and moist air. Keep the plant well watered and the foliage clean by dusting or washing; a dry soil causes the tips of the leaves to turn brown. It does best when pot-bound. To propagate, separate the root into pieces, each with three or more leaves, and place in pots. After potting, take care to avoid over-watering. Too rich a soil or overfeeding causes the yellow-striped form to turn green.

ASTILBE

Dig the root of the Japanese or florists "spirea" (*A. japonica*) in autumn or buy one from a nurseryman. Soak it in water before potting in a good soil mixture. After potting, water the plant thoroughly, and store it in a cool place for 6 to 8 weeks. Then bring it indoors to a well-lighted window and keep it well watered. This is one plant that you cannot over-water. The best temperature for development is 60°F. After the plant is through flowering, it is finished as a house plant, but in the spring it may be planted outdoors in a moist location.

BEGONIA

Begonias have fleshy, succulent stems and unequal-sided leaves.

Fibrous-Rooted Begonias

Begonia semperflorens (Wax Begonia, Everblooming Begonia) and its varieties include Christmas Cheer (large bronze foliage and crimson flowers), Christmas Pink (pink flowers), Luminosa (reddish bronze foliage and deep scarlet flowers), and King of the Reds (green foliage with a bronze edge and scarlet flowers). Stem cuttings give quick results but produce straggly plants. Seed sown in fall or early winter produces a good-sized plant in May or June. The plants thrive in a fibrous soil to which peat has been added, and in a cool temperature and good light; too bright sunlight will cause burning of the edges of the leaves. The plants start to bloom when small, and produce flowers continuously. They make good plants for the house, window boxes, and flower beds.

Foliage Begonias

Foliage Begonias

Foliage begonias, such as the Rex (*B. rex*), Angel's Wing (B. *coccinea*), Spotted (*B. albo-picta*), Metallic-leaf (*B. metallica*), and Beefsteak (*B. feastii*) are grown for their foliage. Rex Begonia needs leafmould and a little lime instead of peat. Foliage begonias require a little less light than the fibrous rooted and will burn if the leaves are wet in strong sunlight. The large-leaved varieties, such as Rex and Angel's Wing, may be propagated by placing leaves flat on the rooting medium with some of the main veins cut and held down with pebbles. Roots form at the cut veins and where the petiole was cut.

Semi-Tuberous Begonias (*B. socotrana*)

The main Christmas-flowering begonias include Lady Mac, Melior, Marjorie Gibbs, Gloire de Lorraine, and Glory of Cincinnati. It is best to obtain new plants each year. But plants may be propagated by leaf-petiole cuttings of medium-sized, well-ripened leaves taken in November and December; such cuttings will root in 4 to 5 weeks if they have a bottom heat of 70°F. The soil mixture should contain considerable sand and peat moss or leafmould. Because of brittle stems, the plants usually need staking.

Tuberous-Rooted Begonias (*B. tuberhybrida*)

Most tuberous-rooted begonias have large, double, or single flowers, and large leaves. They are beautiful dwarf plants with frilled or ruffled flowers of white, pink, salmon, yellow, orange, or red. Tubers are started into growth in flats of half peat or leafmould and half sand, with the crown exposed; this is done at any time from January to April. Apply water sparingly until growth starts, and then more freely.

When the growth is ½ to 2 inches long, place the tubers in 4 to 5 inch pots, using 1 part soil, 1 part leafmould or peat, and ½ part sand. Plant at the same depth as in the flats. When repotting, increase the size of the pot 1 inch at a time. Avoid rapid forcing, since slower growth will produce a plant with more flowers. Good growing conditions are a temperature of 60°F., moist air, and moderate light; direct sunlight may burn the foliage. Flowering occurs from June to September.

After the plants have flowered, cut them half way back on the stem. Leave them in almost dry soil and store at 45°F. until ready to start again, then remove the dry roots. Supply only about half the usual amount of complete plant food during the growth period.

Tuberous begonias may be propagated from leaf-petiole cuttings taken early in the flowering period, or by seed. Sow the tiny seed in January in pans or pots, using a mixture of soil, peat or leafmould, and some sand. The mixture should be high in organic matter with the top inch of soil very fine. Water well, and then sow the seed on top with no soil covering. Cover the pan or pot with a pane of glass and shade it until germination occurs. When the seedlings are large enough to handle, prick them off into flats and later place them in 2½- or 3-inch pots. These plants will bloom during the first summer. Rest them in the fall in order to make stronger plants the second year.

Begonia pendula is good for a hanging pot. The flowers and leaves are large but smaller than other tuberous-rooted begonias.

BRACKETPLANT

The bracketplant (*Chlorophytum capense*) makes an attractive hanging pot plant owing to its long, narrow, variegated leaves, racemes of small, white flowers, and long hanging shoots that produce plants at intervals. It may be propagated from runners or seed or by division. The plants make large root growth; hence to keep a healthy plant, divide it every spring. A suitable potting mixture is 3 parts soil, 1 part organic matter, and 1 part sand. In summer, the plants require considerable water, even regular immersions in a dish of water. In winter, less frequent watering is necessary, but, if the plants become very dry, the tips of the leaves will turn brown. Good light is essential, but shading from the bright sun will preserve the colour of the foliage.

BROMELIADS

The Bromeliads, as members of the pineapple family are called, range all the way from Spanish moss that hangs like curtains from trees in Florida to

Narcissus Plants in Bloom

exotic plants of the Brazilian tropics and plants that belong to the succulents. Some of them store water in vase-shaped receptacles formed by the leaves, and this enables them to live in the dry atmosphere of our homes. The soil-growing types thrive in a general mixture and require no direct sunlight.

BROWALLIA

Browallia speciosa has showy blue flowers at least 1 inch wide. The plant grows 1 to 3 feet high and is somewhat straggly in growth, but may be pinched back to make it branch. *Browallia viscosa* is a small, dwarf, compact plant with small flowers. To make showy pot plants, plant 3 to 6 to a pot. Both species may be propagated from cuttings, but they are usually started from seed sown in July or August. They flower in the winter and require plenty of light and a medium rich soil.

BULBS

Many different kinds of bulbous plants are grown as house plants, including all the so-called Dutch bulbs which are normally outdoor spring-flowering plants. For best results buy high-grade bulbs early in the fall and plant before they dry out.

Soil Culture

All bulbs do well in a good loam to which some coarse sand and peat or leafmould have been added. Partly fill the pot or pan with the soil mixture and plant the bulbs. Avoid packing the soil under the bulbs since this hinders root growth and the bulbs may heave out of the pot. Cover the bulbs with soil, leaving enough room at the top for watering. Hyacinths and narcissi (daffodils) do best when the top third of the bulb is exposed. Place the bulbs close together, but not touching, for the best display. Plant only one variety per pot to encourage even flowering. For best results with hyacinths and to prevent rotting, place a little sand right under the bulb to provide better drainage.

After planting and watering, set the bulbs in a cool place to develop roots before they start top growth. The best temperature for this is just above freezing, that is, 35° to 40°F., but 40° to 45°F. will do. For hyacinths, 50°F. is best. During the cool stage, protect the bulbs against mice.

The pots of bulbs may be placed in a trench outdoors and covered with straw to keep them from freezing. Or, they may be placed in a coldframe and enough straw added on top of the bulb pots to keep out the frost. Another suitable storage place is a dark cool cellar or attic, provided the temperature stays slightly above freezing. A farm root cellar often gives excellent storage conditions.

Some kinds of bulbs, such as paperwhite and Soleil d'Or narcissi, and prepared hyacinth, do not need a cool-storage period.

When the pots are filled with roots and the top growth is about 2 inches high, bring them into subdued light at 50°F. for 2 to 3 weeks to continue top growth and to let the plants become accustomed to light. Then move the plants into full light, at a temperature of 60°F., to flower. Too much heat or too early forcing will ruin the flower buds.

Keep the soil moist at all times, and protect the flowers from strong sunlight and from excessive bottom heat as when situated on top of a radiator. Bring plants out of cool storage in succession. This prolongs the flowering period and is better procedure than planting on different dates.

Water Culture of Bulbs

Some bulbs, such as paperwhite narcissus, Soleil d'Or narcissus, Chinese Sacred lily, hyacinth, and crocus are adapted to water culture. Hyacinths are the only bulbs of this group that need a dark, cool period. For the others, a cool, dark period will promote later flowering and is particularly helpful where the living-room is very warm, but they may be grown and flowered in the same room if the temperature is not over 65°F. and the plants are not placed in strong light until the top growth is 2 inches high. Prepared bulbs, specially treated for forcing, give best results with hyacinths.

Hyacinth Glasses. A hyacinth glass is shaped somewhat like a tall tumbler with a wider, bowl-like part at the top that is the right size to hold one hyacinth bulb. Fill the glass high enough with water so that the base of the bulb is just above, but not touching, the water. Add some fine charcoal to help keep the water fresh. Add more water from time to time as needed and, every few weeks, completely renew the water (using water of the same temperature as that being replaced). Leave the hyacinth bulbs in the dark at a temperature of around 50°F. for 5 to 12 weeks. When the glass is filled with roots and the top growth is 1 to 2 inches high, gradually bring them into light for flowering.

Ordinary Glasses. Ordinary glasses may be used, with pebbles to hold the bulbs at the right height, to anchor the roots, and to keep the bulb from tipping over on its side. The water level should be just below the bulb. With both glass methods, the root as well as top growth may be interesting to watch.

Bowl Culture. The bowl-culture method is very good for growing narcissi, such as the paperwhite, Soleil d'Or, and Chinese Sacred lily, as well as the French-Roman hyacinth. With the hyacinth, an 8-week cool period for root development is needed.

Use a fairly deep bowl rather than a shallow one. At the bottom of the bowl, place a 1-inch layer of coarse sand and fine gravel. On top of this layer, place at least 2 inches of pebbles, and plant the bulbs in these pebbles. Add some granulated charcoal to the sand layer to help keep the water fresh. Add water until the base of the bulb is just above water level. The bulbs should not touch each other or the sides of the bowl.

In another bowl-culture method, fibre is used. This method is good for the polyanthus group of narcissi, lily of the valley, hyacinth, early tulip, trumpet daffodil, crocus, scilla, and snowdrop. Fill the bowl with bulb fibre (selected granular peat plus some oyster shell and charcoal) to within 2 inches of the top. Then cover the fibre with water and let stand until the fibre is well soaked. Drain off excess water. Place the bulbs on this moist layer and pack dry fibre around them, being sure the bottom layer is not firmed too much for easy root penetration or the bulbs may shove themselves out of the bowl. Place the bulbs close together but not touching each other or the bowl. The tops of the bulbs should be level with or a little higher than the top of the bowl.

Place the bowls of bulbs in a cool place with subdued light until the roots are well developed; then gradually move them to full light. The best temperature after the cool period is about 60°F. Add enough water from time to time to keep the fibre moist but not sodden.

All these bulbs, except the paperwhite and Soleil d'Or (which are not hardy in Ontario) may be planted outside after forcing and will likely flower the second year.

CACTI AND OTHER SUCCULENTS

Cacti

Succulents store moisture in their tissues and so can withstand long drought periods. Therefore cacti are succulents and belong to the family Cactaceae (Cactus family). Any plant of this family is called a cactus. Cacti may be bought from a dealer, grown from seed, or grown from cuttings. They are widely

Cacti (Opuntia, Mammillaria, Astrophytum, Mammillaria, Lemaireocereus)

known for their oddity of form and some for their beautiful flowers. They withstand well the warm, dry air of homes and require infrequent watering. They are slow growing, long living, and need repotting only every 2 or 3 years.

Cacti require plenty of light. While growing and flowering they require more water that at other times. When the plant looks unhealthy or shrivelled, the cause is usually too much water rather than too little. Most cacti in full growth benefit from a weak liquid fertilizer unless repotted recently. A good potting mixture is equal parts of potting soil and sharp sand.

In sowing the seed of cacti, fill a 5-inch flower pot to ½ inch from the top with the potting mixture; drop in the seeds; cover very lightly with a fine soil mixture; and then place in a room at 70° to 80°F. Cover with glass to keep the surface of the soil moist. As the seedlings grow, gradually remove the glass. Transplant when the seedlings are large enough.

Succulents Other Than Cacti

The succulents that are not cacti occur in a wide range of families, including the amaryllis, daisy, spurge, milkweed, lily, agave, and sedum. All succulents require good light, and some require full sun. Their soil requirements are much the same as for cacti, usually equal parts of good loam and sharp sand. The space at the top of the pot that is left for holding water is often filled with small stones or broken brick to prevent crown rot. The plants should not be kept too wet or the roots will rot. If the plants are kept in a cool room, they may need watering only every week or two, but if kept in a warm room they will need more frequent watering. They may be propagated from seed, by both leaf and stem cuttings, and by division when the growth habit permits.

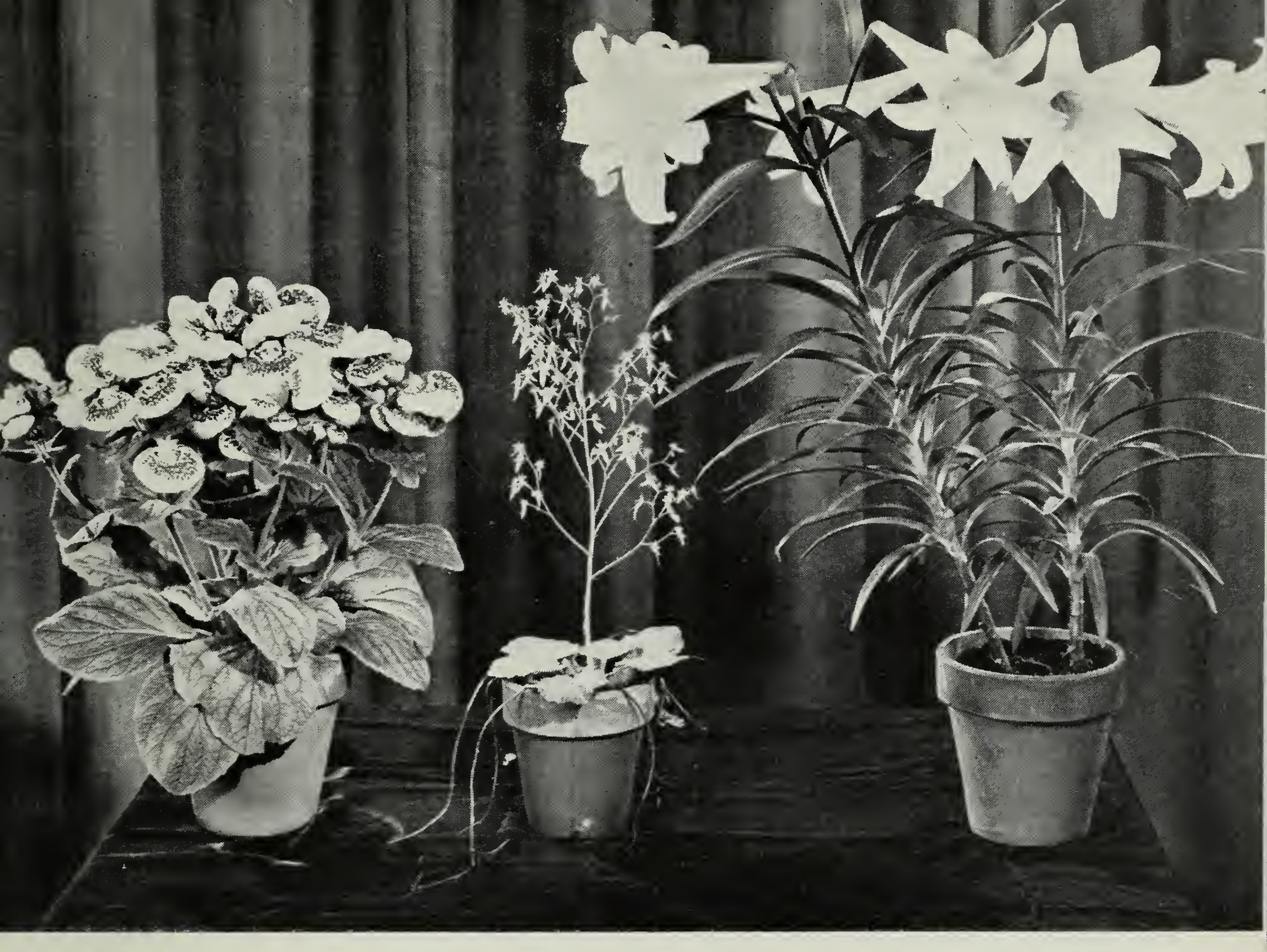
Crassula. The crassula most often seen in homes is the Jade Plant or Chinese Rubber Tree (*Crassula arborescens*). This tree-like plant has small, white, star-like flowers in midwinter, when it is 7 years or more old. It is propagated by stem cuttings rooted in moist, sharp sand. The plant must not be kept too wet or it will rot and die.

Sedum (**Stone Crop**). There are many sedums. Some are grown outdoors where they make good clumps of foliage, and many of these are hardy to our winters. Some of them will make good house plants, but others, not hardy, should be wintered in the house. The tender kinds are best for home use as hardy plants seldom thrive for long in the warm and dry house atmospheres. Sedums are propagated by division of the plant or by stem cuttings.

Echeveria, Sempervivum, and Cotyledon (Hen and Chicks). The leaves are arranged in a rosette. Smaller rosettes grow around the base, resembling a hen with baby chicks. The tall flowerstalks are lined with small, pretty flowers. To propagate, separate the rosettes of leaves from the main plant and root them in sand.

Kalanchoe. There are two groups—(1) Air plants or life plants. The leaves

Succulents (Aloe, Crassula, Aeonium, Haworthia, Kleinia, Gasteria, Echeveria)



Calceolaria, Saxifraga sarmentosa, Easter Lily

give rise to young plants that fall off and grow if they land on a suitable medium. One of this group, *K. pinnata*, will produce young plants on the edge of leaves that are removed from the plant, even if these leaves are pinned on a curtain. (2) Young plants are not produced on the leaf edges. The dwarf Tom Thumb has red flowers at Christmas or a little later. It is propagated by seed and by leaf or stem cuttings.

Gasteria. (Warty Aloe or Ox-tongue). The plants have thick, fleshy leaves which may be smooth or warty. Some species are spotted or mottled with white, pale green, or copper.

Haworthia (Cushion Aloe). The plants have fleshy leaves that grow in rosettes.

Aloe. Several species of aloe do very well in the house. Some of them, such as *A. aborescens*, grow quite large, and some, such as *A. variegata*, remain small.

CALCEOLARIA

Slipperplant

Calceolaria has balloon-like, slipper-shaped flowers. The colour is usually yellow, heavily spotted with brown. Plants in bloom are usually obtained from florists as gift plants. The seed is sown in August. It is very small and difficult to grow in the early stages. When the seedlings are large enough to handle, they are transplanted to 1½ inches apart in flats, later to 3-inch pots, and, finally into 5- or 6-inch pots. A suitable soil mixture is equal parts of soil, sand, well-rotted manure, and leafmould or peat. This mixture should be slightly acid, about pH 6.5. If the soil is too alkaline, over-watered, or too high or too low in nitrogen, the foliage will turn yellow. The best growing temperature is 50° to 55°F. A plant bought in flower from the florist should continue to remain in bloom, with good light, even in temperatures of just over 70°F., for 2 to 3 weeks.

CALADIUM

The Fancy-Leaf Caladium (*C. bicolor*) has variegated leaves of red, green, and white. It is grown from rhizomes planted in March in 3- to 4-inch pots and later repotted to 5- or 6-inch pots, using 3 parts of coarse loam, 1 part leafmould, and 1 part of well-rotted manure. When provided with partial shade and high humidity, beautiful plants should be expected by August. In October, when the leaves begin to dry up, gradually rest the plants in their pots and store at 60°F. (keep the soil slightly moist). New plants are obtained by dividing the rhizomes.

CALLA

The gardener's and florist's calla (*Zantedeschia aethiopica*) which is discussed in this bulletin is a native of Africa and should not be confused with *Calla palustris,* the water-arum of our Canadian bogs and waterways. An older scientific name is *Richardia africana.*

The large, white, upturned, trumpet-shaped flowers and the large, triangular, green leaves make plants that should stay in flower for 5 to 6 weeks. Calla thrives in a cool temperature and good light but not in strong sunlight. While in growth, plenty of water is required, even to letting the plant stand in water for an hour or so. Although it is an African bog plant, it should not be left standing in water too long and it should have good drainage.

Flowering occurs in winter to early spring. In summer, rest the plant in a cool place with only an occasional watering to make sure the tubers do not dry out excessively. In the fall, repot the tubers in such manner that the crown shows just above the soil level. The soil should be fertile and contain more peat than for most other house plants. The plant is propagated from offsets which should be kept growing, without a rest period, until they flower, which is usually the second winter. Other callas are the Red or Pink Calla (*Zantedeschia rehmannii*) the Spotted Calla (*Z. albo-maculata*), and the Yellow or Golden Calla (*Z. elliottiana*).

CAMPANULA

Italian Bellflower

The Italian Bellflower (*C. isophylla*), as a house plant, does best in a well-lighted, cool room in winter and a verandah or window box in summer. It is best kept in a 5-inch pot and should be divided when growth becomes crowded. A good potting mixture is 3 parts loam, 1 part peat, and 1 part of coarse sand.

CARNATION

The florist's carnation does not make a good house plant. The outdoor types, which are grown as annuals, may be dug in the fall when the soil is moist. They are then potted firmly, and the buds, which set outdoors, will open and flower. After this flowering, they are of no further use.

CHRISTMAS CHERRY

The Christmas Cherry or Jerusalem Cherry (*Solanum pseudo-capsicum*) is a cheerful berried plant for Christmas. Most strains have red berries; some have yellow berries. Sow the seed in January or February. When the first true leaves appear prick out the seedlings about 1½ to 2 inches apart in flats. Later, when the plants are big enough, transplant them to 2½-inch pots. During the early stages, keep the plants cool (55° to 60° F.).

After danger of frost is over, set the plants at least 16 inches apart in the garden. During their stay outdoors supply enough water and fertilizer to ensure good growth. Excessive nitrogen promotes too much foliage and slows down flowering and the setting of berries. These plants must flower and set fruit outdoors as they set fruit poorly indoors.

After adequate fruit is set, dig the plants and bring them indoors before heavy frost. Retain as much soil as possible on the roots. Place in 5- or 6-inch pots in a cool location, out of direct sunlight, for several weeks. Keep the plants well watered to encourage them to become established. Then place the plants in good light in a cool temperature (54° to 60°F.). From then until Christmas they must not wilt; otherwise the leaves may drop off. They should not be fed as this will cause excessive foliage growth that hides the berries. Seed may be saved from the berries and dried or sown at once. This plant is highly susceptible to gas damage.

CHRYSANTHEMUM

Pot chrysanthemums are started in greenhouses, grown there until in bloom, and then sold as gift plants. Place the tender types in full light in the home, and keep them cool until the flowers have lost their attractiveness. The period in bloom is commonly 2 to 4 weeks. Plants of the tender types of "mums" are usually discarded after bloom.

The hardy types of "mums", however, can be bought in bloom in small pots from florists as a feature for Mother's Day and can subsequently be grown outdoors. When the plants are past flowering cut them back to 3 or 4 inches, continue watering until after danger of frost, and then set them in the garden. These plants bloom in the fall of the same year, but if flowering is too late for our season they may be dug and potted in large pots to flower in the house.

CINERARIA

Cineraria provides brilliant daisy-like bloom in great variety. Seed sown in September will give flowering plants for Easter. The plants thrive in a cool temperature with good light. If the sun is too bright and hot the plants will wilt, even with moist soil. Keep the soil moist but not over-watered, and fertilize often enough to form shapely plants but not excessive foliage.

CLIVIA

Clivia is a bulbous plant with wide, strap-like leaves. The foliage stays green all year and clusters of orange-red flowers appear in the spring. This plant thrives in a large pot and needs repotting only every 3 or 4 years. A suitable potting mixture is 6 parts of soil, 3 parts of peat or leafmould, and 1 part of coarse sand. In the spring, when the plants start to make new growth and produce flowers, they need more water and a light feeding. The rest of the year, keep them in a cool room, or in the summer outside in a cool place. The soil should be moist at all times. Propagation by division and repotting are done after flowering.

COLCHICUM

Colchicum, a bulbous plant, is interesting because it blooms in a dry state without soil. The bulb may be placed on a window sill where it will grow and flower.

COLEUS

Coleus is a useful foliage plant for outdoor bedding, window boxes, and in the house. It has a wide range of colours. From seed, one seldom obtains two plants with exactly the same colours or markings. Cuttings produce plants identical with the parent plant, and they are superior to those grown from seed. As

Coleus Plants

Philodendron, German Ivy, Peperomia, Philodendron, Dracaena

a house plant, coleus needs sunlight, yet may be shaded during the heat of the day. To obtain a bushy plant, keep pinching back the plant to make it branch.

CROTON

Croton is a woody plant up to 6 feet tall. It is a very slow grower and is noted for its firm, glossy leaves in a wide range of colours. The leaves are produced in a compact fashion and the plant rarely becomes straggly. It needs good light, but not direct sunlight, and a warm, moist temperature of about 75°F. The soil should contain considerable peat or leafmould. Cuttings may be rooted in water or sand; aerial layering may be done in March or April.

CYCLAMEN

Cyclamen is started from seed and takes about 18 months to flower. Buy plants from a florist in the fall, when they are about 12 to 14 months old, and grow them on to flowering; or, better still buy a plant already in flower. Cyclamen does best in a cool location (55° to 60°F.), and needs good light but should be shaded from hot sun. It thrives in a light soil that contains considerable leafmould. The tuber should be at least half out of the soil to prevent the leaf and flower stems from rotting. Apply water early enough in the day so that the base of the stems become dry before night. Cyclamen has beautiful flowers and nicely marked round leaves. If conditions are right, it will flower for 4 to 8 weeks.

After flowering, an old plant may be carried through the summer by plunging the pot in a sandy soil and gradually letting it become quite dry. In the fall, repot the plant and gradually bring it into growth, and this will often make a nice flowering plant the second year.

DRACAENA AND CORDYLINE

Dracaena and cordyline are very closely related and their requirements are the same. The chief dracaena is *D. fragrans*; this species includes horticultural varieties such as *Victoria*, *lindenii*, and *massangeana*. The leaves are 10 (or more) inches long and about 2 inches wide. The cordyline usually grown is *C. australis* (often called *C. indivisa* or *D. indivisa*). It has long narrow leaves.

These plants are good in window boxes, as centres for hanging pots, and in ferneries. They do well in either sun or shade and thrive particularly well in an east window. They may be propagated from seed or from stem sections laid horizontally on moist sand or peat, but it is usually best to buy plants from a florist.

ELODEA

Waterweed or Ditch Moss

Elodea is a useful plant for aquariums. To grow it, place the plant in a small pot and submerge completely under water.

FERNS

Ferns thrive in medium light but should not be exposed to strong sunlight. An east, west, or north window is a good location. A suitable soil mixture is 3 parts loam, 1 part sand, 1 part leafmould or peat, and 1 part well-rotted manure. The plants may need watering daily or only every 3 or 4 days depending on the temperature and the humidity, but they should not stand in water.

Keep ferns out of draughts. They are easily damaged by brushing against the tips of the fronds. They are very subject to scale and mealy bug. Apply a weak application of complete liquid fertilizer every few weeks once the plants are established in their pots.

Repot the plants in February. Remove the plant from the pot and cut off (not pull off) the fronds close to the crown. Loosen the roots and separate the plants. Then repot all in the one pot or separate as desired. The crown should be almost covered with soil.

Boston Fern (*Nephrolepis exaltata bostoniensis*)

The variety *bostoniensis* is a "sport" from *N. exaltata* and has fronds that are more arching and graceful than the original species. Some other sports are

Boston Ferns

elegantissima, magnifica, robusta, scholzelii, scottii, superbissima, and whitmanii. They are propagated from runners or by division.

Holly Fern (*Crytomium falcatum, C. butterfieldii, and C. rochefordianum*)

Holly fern makes an attractive indoor plant because of its glossy green foliage and holly-shaped leaflets. There are dwarf varieties, such as variety *compactum.*

Birds-Nest Fern (*Asplenium nidus*)

The bird's-nest fern is striking with its ring of erect, flaring, bright-green fronds that grow from the crown in a nest-like centre effect. In a mature plant the fronds are 2 to 4 feet long and 2 to 8 inches wide. New fronds grow inside the old ones. This fern is propagated from spores. In houses with a hot, dry atmosphere, it is usually short lived.

Staghorn Fern (*Platycerium*)

The staghorn fern, of which there are 12 or more species, is an epiphytic plant; that is, it grows on another plant or on some elevated support. It is highly decorative when grown in a hanging wire basket that has been lined with sphagnum moss and filled with equal parts of peat, soil, and sand. The young plants are set in the sides as well as the top of the basket.

Staghorn fern produces two types of fronds: (1) sterile, and (2) spore bearing. The former grow flat and close to the object on which the plant is situated and furnish a home for the young plants. The latter extend out from the object on which the plant is growing and are branched, resembling a stag's horns. The spores look like a patch of rust and grow on the underside of the fronds towards the tips. Propagation is by spores and division.

Hare's-Foot Fern (*Phlebodium aureum*)

This fern has a furry-appearing rhizome development which occurs normally on top of the soil, hence the name hare's-foot fern. It needs plenty of room in a pot as the fronds may spread as much as 4 feet. Apply water only when the plant is dry and then give it a really good soaking. It requires more sunshine than most ferns. Syringe the foliage frequently. Propagation is by division or from spores.

Spider or Table Ferns (*Pteris Sp.*)

At least five spider fern species are in cultivation, and each species has several varieties which provide variegations, odd shapes, and many types of growth. There are many dwarf types, but a few have fronds up to 3 feet long. The fronds are much divided and often crested. Spider ferns are useful as fillers in large containers and fern dishes and as individual plants. They stand adverse conditions better than most ferns. Propagation is from spores or by division.

Maidenhair Fern (*Adiantum*)

The Maidenhair fern thrives in a conservatory but seldom does well in the house because of its need for a cool location, high humidity, and subdued light. Propagation is from spores or by division.

Piggy-Back Fern (*Asplenium bulbiferum*)

Asplenium fern is frequently called the piggy-back fern because of the tiny plants that develop along the outer edges of the fronds. These tiny plants may be planted when they are large enough. This fern has finely divided fronds and makes an attractive house plant.

FREESIA

The freesia is grown from a corm. The corms are somewhat tooth shaped. Plant them in the fall with the pointed end up. Set the large-sized corms 3 to 4 inches deep and the smaller ones 1 to 1½ inches. If the corms vary much in size, plant each size separately, 6 to 10 in a 5-inch pot or 10 to 15 in a 6-inch pot. Use a soil mixture of equal parts of fibrous loam, leafmould, and well-rotted manure. The soil under and covering the corms should be firmed just enough to avoid air pockets and to ensure the corms being in close contact with the soil. After planting, water once thoroughly and thereafter enough to retain the moisture.

Freesia makes top and root growth simultaneously and so needs at least partial light and a temperature of 40° to 50°F. After top growth has appeared, increase the watering, otherwise the leaf tips may turn brown. When the shoots are 1 inch high, move the plants into full light and a temperature of not over 65°F. Freesia requires 14 to 18 weeks to bloom and usually needs support. After bloom, reduce the watering and place the plants in partial shade, for 3 to 5 weeks. When the foliage is yellow or is dead, remove the corms from the soil and store them until time for repotting, or leave them in the dry soil. For a succession of bloom, plant corms at intervals of 4 to 8 weeks.

Freesia may also be grown from seed. Soak the seed in water for 24 hours and then sow in the pots in which the plants will bloom. The seed is sown in the fall and the plants may flower the first year. Freesia seedlings are not easily transplanted.

FUCHSIA

Fuchsia or lady's ear-drop is noted for its attractive foliage and beautiful hanging flowers. The single-flowered varieties grow faster than the smaller, double varieties and make much more attractive plants. They thrive in a temperature below 70°F. and an eastern exposure. If a southern window is used, protect the plants from bright sun.

Fuchsia needs plenty of water and frequent syringing. If the plants become too dry, the leaves and flower buds may drop off. A good soil mixture contains considerable organic matter such as leafmould, peat, and well-rotted manure, and enough sand to provide good drainage. In the early stages of growth, repot the plants frequently, gradually increasing the size of pot. Fuchsia is a woody plant and may grow for several years. Propagation is by stem cuttings made from new growth. For winter flowering, rest the plant in summer, then repot and start into growth in September after a severe pruning. Pinch the new shoots to ensure a nicely shaped plant. For summer flowering, rest the plants in winter. While the fuschia is in growth, avoid exposure to draughts and sudden changes of temperature.

To develop a standard or tree-like plant, root a cutting and keep it in continuous growth, meanwhile removing all side shoots until the stem reaches the desired height. Then pinch off the terminal to make the plant branch at the top. Pinch back the new branches to make a bushy top. Allow the plant to flower before resting. During the first year, the bushy top will be sparse but, after resting and pruning of the old wood and pinching of the new growth, a very good standard will be developed. This standard requires support because of the brittle wood.

GENISTA

Cytisus canariensis, a shrubby evergreen legume, is sold by florists as genista. It bears racemes of small, yellow, pea-like flowers. Genista is propagated from cuttings, which are taken after flowering and rooted in sand. When the cuttings are nicely rooted, place them in 2½-inch pots, and later repot into 4-inch pots, then to 6-inch pots, as needed. Plunge the pots outdoors for the summer and keep them watered. In the fall, before frost, bring the plants indoors and store in a light, cool place with a temperature of not under 50°F. at night and not too warm during the day. Plenty of sunlight and water are required. Genista blooms from spring to early summer. Established plants may be carried over for the second year.

GERANIUM

Geraniums are again becoming popular as fanciers' flowers. There are hundreds of varieties in many different colours. Some varieties have coloured or attractively marked or crinkled foliage. Some are grown for their scented leaves, and there are dwarf or pygmy varieties.

Pelargonium hortorum (*Zonal, Fish, or Horseshoe, or Common Geranium*)

To grow geraniums successfully in the house, start new cuttings each year. For winter flowering, root the cuttings in the spring and place in 2½-inch pots. When the roots become crowded, move the plants to larger pots and finally to 6-inch pots. During summer, potted geranium may be plunged outdoors and kept well watered. To develop a nicely branched, low, compact plant of a good

Common Geranium, Variegated Common Geranium

Martha Washington Geraniums

shape, start to pinch when the plant is about 5 inches high and continue until at least 6 branches have formed near the base.

In the fall, before frost, bring the plants indoors to a temperature of 65° to 75°F. The geranium is a sun-loving plant and will flower only if it receives good light. In winter, keep the plant slightly pot-bound and feed just enough to keep the foliage a bright green colour.

For spring flowering, root cuttings in sand in the early fall. Geranium cuttings can even be rooted successfully in a glass of water. When the cuttings are nicely rooted, place them in 2½ to 3-inch pots, using a mixture of 7 parts soil, 3 parts organic matter, and 2 parts sand. Repot the plants into larger pots when they become root-bound.

Old, leggy plants may be cut back to 2 to 3 inches, most of the soil removed from the roots, and the plant repotted into a smaller pot. Then, water the plant sparingly, keeping the soil barely moist until new growth starts. When there is more foliage, the plant will need more water.

Old geraniums may be stored in a cool cellar for the winter. Leave as much soil as possible on the roots and keep the plants almost dry. Towards spring, repot the plants, cut them back part way, and give full light and watering.

Pelargonium domesticum

The Martha Washington or pansy-flowered geranium blooms in the spring and is more difficult to grow than the zonal type. Different varieties have a wide range of colours, such as blotched or marked with dark purple on a background of shades of red, pink and mauve, or white. Make cuttings in late August or early September and handle like the zonal type.

Pinch back the plants several times, removing only the growing tips. Make the last pinch in December for April flowering, and in February for Mother's Day flowering. Greenhouse-grown plants may drop their open flowers when moved to the dry atmosphere of the home, but flower buds that open in the home should continue to flower.

After flowering and all danger of frost is over, plunge the plants outdoors and partially rest them in summer. In the fall, even if most leaves have dropped, cut back and repot the plants (as with the zonal geranium).

Pelargonium limoneum

Scented geranium has fragrant foliage. The leaves are sometimes used to flavor apple jelly. The culture is the same as for the zonal geranium. The flowers are small and not showy.

GLOXINIA

Gloxinia has large, velvety leaves and large, broad, tubular flowers of many colours. It is grown from tubers, cuttings, or seed. Plant the tubers in February, with their crowns just showing, in a mixture of equal parts of peat and sand. When the plants are large enough, place them in 5- to 6-inch pots, using 1 part soil, 1 part leafmould or peat, and ½ part sand. Set the plants at the same depth as in the starting mixture. They need a temperature of 60° to 65°F. and good light, but shade them from direct, strong sun. Do not over-water or wet the leaves. Gloxinia blooms from May to September. In the fall, gradually dry and rest the tubers in pots of soil, at a temperature of not under 45°F., until the following February, then start them again.

Gloxinia plants may be started from leaf cuttings. A cutting, when rooted, will produce a tuber and then a plant which will flower in about 5 months.

Sow the seed in early spring. Culture is the same as for the tuberous begonia. From seed to flower takes about 7 months.

GYNURA

The velvet plant (*Gynura aurantiaca*) has ovate leaves covered with purple hairs and thrives in a general purpose soil and good light. The old growth loses its purplish, velvety appearance, and the flowers have an unpleasant odour. Topping produces new side branches and prevents flowering. Propagation is by cuttings.

HELXINE

(Baby's Tears)

Baby's tears, Japanese moss, or Irish moss has very small leaves, low growth, and a creeping habit. It does well in nearly every house. When planted

Schizanthus and Hydrangea

in a 5-inch pot, it will cover the pot about 1 to 2 inches deep and creep over and down the sides of the pot. The creeping part may be trimmed with scissors to keep it from touching or soiling the table cloth.

Baby's tears is readily propagated by planting rooted pieces or small shoots in a good soil mixture. It grows well in partial light, such as a north window. It needs plenty of water but requires good drainage. When well established, give it an occasional light feeding of a complete plant food. The optimum temperature for baby's tears is 55° to 60°F., but it can withstand temperatures up to 75°F. Very susceptible to gas injury.

HIBISCUS

Chinese hibiscus or rose-of-China (*Hibiscus rosa-sinensis*) with its many hybrids and varieties, is a large shrub or small tree reaching a height of 30 feet. Because this shrub produces its large, beautiful flowers on the new growth it can withstand hard pruning, and so may be used as a pot or tub plant.

Rest the plant during the winter by keeping the soil fairly dry. In the spring, cut back about one-half and repot in a general soil mixture. Place in full light for summer and fall flowering. Propagation is by cuttings from the new growth. *Malvaviscus,* closely related to the Chinese hibiscus, is grown in the same manner.

HYDRANGEA

The florist hydrangea (*Hydrangea macrophylla*) is one of the most popular plants for Easter and Mother's Day. In sunny or very warm locations it may require watering twice a day, but it should not stand in water. When in bloom, shade the plant from hot sun. It thrives in a temperature of 60°F., but will tolerate higher temperatures.

To carry over this plant for the next year, cut it back half way after bloom. Keep it in the light and continue to water it, although it will not dry out so fast after it has been cut back. After danger of frost is over, plunge the pot outdoors in acid soil or peat in partial shade. Keep the plant watered as needed and feed with a complete plant food every two weeks all summer; on alternate weeks, feed with iron sulphate (1 ounce to 2 gallons of water). If the plant is growing too tall, pinch the new growth in early July. This will allow time for new shoots to develop and flower buds to set. In early August, move the plants to full light to promote bud setting. After September 1, stop feeding, and move the plants into a cool, dark storage place before frost. The plants require very little water in storage at 45°F., but keep the soil moist. While in storage, the foliage will drop off and should be removed to prevent mildew.

For Easter bloom, place the hydrangea in a temperature of about 60°F. soon after Christmas. Repot if necessary, using 1 part clay loam, 1 part acid peat, and ½ part well-rotted manure, or peat alone. Add a 2-inch pot of iron sulphate to every 2½ bushels of the potting mixture. Keep the soil in the pots just moist until the plants have made new roots and some shoot growth; then gradually increase the watering. Feed with a complete plant food and iron sulphate on alternate weeks until the plants have finished flowering. At a temperature of 60°F., the buds should be the size of a pea 8 weeks before Easter. For Mother's Day flowering, bring the plants out of storage about January 15.

Blue flowers are obtained, in a pink variety, by adding aluminum sulphate (3 ounces to 1 gallon of water) to the soil every 2 weeks, starting after the plant is growing in late January or February. A pH of 5.5 is also needed; if the soil is not acid enough the flowers will be mauve or purplish; if the pH drops to 4.4, the free aluminum in the soil will cause root burning. To raise the pH, add lime. The iron sulphate intensifies and makes clearer the blue or pink flowers; it also corrects or prevents chlorosis (pale or yellowish foliage). For blue flowers the second year, the soil must again be treated with aluminum sulphate.

HYMENOCALLIS

(Spiderlily; Ismene)

Spiderlily (*H. calathina*) a bulbous plant, has creamy white flowers with long, narrow guard petals and a pleasant fragrance. Plant several large-sized bulbs in a pot, apply water, and grow them in partial shade until near flowering time. Then move the plants to full light and increase the supply of water.

Three Types of English Ivy, Grape Ivy (rear center)

IMPATIENS OR PATIENCE PLANT

The patience plant may be started from seed sown in May to June or from cuttings rooted in early July. After rooting, plant it in a potting mixture of 7 parts soil, 3 parts organic matter, and 2 parts sand. If the soil is acid, add a little lime. The plant grows and flowers best in a small pot. It requires only light feeding when it is well established. Provide partial shade in summer and full light during the dull winter months. It blooms almost continuously. An old plant may be cut back to produce new growth, but it is generally wise to start new plants from cuttings taken from the old plants when they become too large.

IVY

The four plants discussed here are included together because of the common term "ivy". However, they belong to widely different and unrelated families.

English Ivy (*Hedera helix*)

Some varieties of English ivy are dwarf with small leaves; others are tall plants with large leaves. Both types have green or variegated leaves, depending on the variety. English ivy is attractive when planted in pots and trained on a trellis or other support, in hanging baskets, in bracket pots, in window boxes, or in water culture. This ivy is highly resistant to dry air, high temperature, and changes of temperature. Some of the dwarf types are not good climbers but thrive as trailers or creepers.

To propagate, root tip cuttings in sand or water. If placed in water, the cuttings should be 7 to 8 inches long and bottom leaves removed so they will not rot. Keep the cuttings in subdued light until they are rooted, and then pot them in a soil mixture high in organic matter. The plants require plenty of water and need syringing frequently to keep the dust off the foliage. They thrive in good light but they do not need direct sun. If checked in growth, ivy is more subject to aphids, scale, mealy bug, and red spider.

German Ivy (*Senecio mikanioides*)

German Ivy has light green, fleshy leaves, and is coarser and less attractive than the English Ivy, but it grows more rapidly. It is useful in window boxes and hanging pots on the porch. It is grown from cuttings rooted in sand or water.

Grape Ivy (*Cissus rhombifolia*)

Grape Ivy is an evergreen tendril climber with leaves consisting of three glossy, pointed and sharp-toothed leaflets. Others include Cape Grape (*C. capensis*) and Kangaroo Vine (*C. antarctica*). All these plants are of easy house culture and thrive in a general purpose potting mixture. The soil should be moist at all times. The plants thrive in an east or west window, but, if they are grown in a south window, they may be shaded by thin curtains when necessary. Propagation is by cuttings.

Kenilworth Ivy (*Cymbalaria muralis*)

This dainty little plant has small flowers and small circular 3- to 7-lobed leaves. It is also known as *Linaria cymbalaria*. Grow it from cuttings or seed.

KOHLERIA

Kohleria has soft hairy growth. The scarlet, orange or vari-coloured flowers are solitary or in clusters in the axils of the leaves or in terminal racemes. This colourful plant thrives best in moderate light, a soil high in organic matter, and a temperature of 65°F.

LANTANA

Lantana is a shrub with showy, flat-topped, vari-coloured flower heads. It makes a good subject for a window garden, and flowers for a long time. It thrives in a temperature of 60° to 70°F. and requires abundant sunshine.

Propagation is from cuttings or seed started in May; then the plant may be transplanted into the garden for the summer. For winter flowering indoors, pinch the shoots all summer to prevent flowering. In the fall, pot the plant in a soil mixture that contains considerable peat. After a week in a shady location, move the plant into full sunlight.

An old plant may be cut back to one-fourth its height and will produce new shoots for the following winter. During the summer plunge it in the garden and keep it pinched as with young plants, or let it bloom in the garden. New plants started in May from cuttings or seed make the best house plants.

LEOPARD PLANT

Leopard Plant (*Ligularia kaempferi aureo-maculata*) has ivy-shaped leaves that are a shiny green with yellow or white spots on the top surface; the underside of the leaves is more or less woolly. This plant thrives in an east or west window in the winter and a cool shady porch or other shady location outdoors in summer. The flowers are not attractive and not often in evidence.

Leopard Plant thrives in a general mixture that contains some peat or leafmould. When potting, do not pack the soil too firmly. In summer the plant needs copious watering, but in winter supply just enough water to keep the soil moist. When the plant becomes too large for its container, either repot to a larger pot or divide it.

LILY

Easter Lily (*Lilium longiflorum*)

The Easter lily is available in types such as the Croft, Kenyon-Davidson, Estate, and Creole. The Croft has been a favourite for a long time. The Estate resembles the Croft but takes about 2 weeks longer to flower. Creole is inclined to be too tall. Kenyon-Davidson is sometimes earlier and shorter than the Croft and often has more flowers.

The bulbs usually become available from the dealers in October or November. Plant them at once, or store at 50°F. and pot about December 1. Use a soil mixture that contains plenty of peat or fibre and is slightly acid. Plant in 5- or 6-inch pots, one bulb per pot. Place 1 to 2 inches of soil in bottom of the pot, and set the bulb, but do not firm the soil under the bulb. Barely cover the bulb with soil, and then apply water. Later, when the growth is about 6 inches high, fill the pot with more of the soil mixture, leaving enough room for watering.

Once potted, keep the temperature at 60°F.; about January 1, raise it to 65°F. if Easter is early. During growth, provide plenty of light and a moist soil. Until the small buds start to form, light syringing is beneficial; after bud set, moisture around the buds may cause rot. After the plants are 6 inches high, feed them with a complete soluble fertilizer, or a little nitrogen fertilizer, such as ammonium sulphate, every 2 or 3 weeks.

When the buds are just visible, the plant requires 5 weeks to flower if grown at 60°F. When the buds start to bend over, 2 weeks elapse until bloom. If the plants are late, raise the temperature to 65° or even 70°F. Blasting, or drying of the unopened flowers, is caused by too high a temperature or too dry an atmosphere. Splitting of the flower may be due to a severe check in growth.

After flowering, the bulbs are useless for forcing again, but if the bloom is cut off and the bulbs planted outdoors after frost, they may bloom again in the fall and sometimes will winter over if protected.

Regal Lily (*Lilium regale*)

Regal lily is one of the hardy lilies that may be forced indoors in the same way as Easter lily. It is yellow or darker colour at the base of the petals, and so is not a good white for Easter. Also, timing the flowering for Easter is more difficult.

LILY OF THE VALLEY

Lily of the valley (*Convallaria majalis*) has fragrant white flowers. It is usually grown indoors from specially prepared root crowns or pips. Plant these crowns in sandy soil, moss, or bulb fibre; leave the tips of the crowns uncovered. Plant 6 to 7 crowns in a 5-inch pot. Water thoroughly and place in a dark location with a temperature of 65° to 75°F. for 3 weeks. To provide a dark location such as this, one may use a clothes closet or cover with an inverted box or flower pot. At the end of the 3-week period, or before if the bottom flower buds are nearly open, gradually move the plants into the light. The flowers appear in 3 to 4 weeks. When in flower, these plants will last longer if the temperature is lowered to 60° to 65°F.

The plants may also be grown from crowns or pips direct from the flower bed. In early October, dig and select crowns of about ¼ inch or more diameter and plant in sandy soil, keeping the tips of the crowns exposed. Cover with moss and leave outdoors to freeze; too severe freezing may damage the crowns. After the freezing treatment, place the pots in a cool, dark location with a temperature of 40° to 45°F. for 6 weeks; then move them to a warm location and gradually expose to full light. It is usually better and easier to buy prepared crowns.

MARANTA

Arrowroot

Arrowroot (*M. bicolor*) has variegated foliage. Grow the plant in a soil high in organic matter (as for begonias). Water well after potting, and then keep the soil moist. The plant thrives in partial shade with a daily syringing of water. Propagation is by division.

NEPHTHYTIS

Nephthytis is a climber with arrowhead leaves. It will grow well in a north window but thrives best in a west or east exposure. It will tolerate overwatering or exceptionally dry conditions, but for best results avoid both extremes. Propagation is usually by cuttings rooted in water or sand. After the plant is well rooted, pot in a general potting mixture.

NORFOLK ISLAND PINE

The pyramidal tree of Norfolk Island pine (*Araucaria excelsa*), with its branches borne in symmetrical whorls, is the aristocrat of the potted evergreens. In the Norfolk Islands, where it is native, it grows 200 feet tall. As a house plant it thrives best in a west or east window and in a temperature of 50°F. in winter. To keep a symmetrical shape, turn the plant frequently so that all sides receive an equal amount of light. Young plants may be bought from a dealer or they may be grown from seed. When the plant becomes too tall, cut off the whole top, including the top whorl of branches, and root it in sand in a closed, humid propagating frame. When it is rooted, increase the air by gradually opening the frame. Pot in a general potting mixture.

OLEANDER

Oleander (*Nerium oleander*) is a shrubby plant that is prized for its pink or white flowers. It is a rapid grower; a 2-year-old plant is usually too large for the house. Propagation is by cuttings. As a house plant, grow the oleander in a south window to ensure plenty of light. It makes a good tub plant for the porch; it may be carried over winter in a cool basement.

OXALIS

The oxalis plant, often referred to as the shamrock, has a leaf with 3 heart-shaped leaflets. The flowers are usually yellow, pink, lavender, or purple. Wood sorrel is a common weed with small flowers; the cultivated varieties have large leaves and flowers often 1 inch across.

Bulbs bought in the fall should be planted as soon as possible. Plant them singly 1-inch deep in 3-inch pots or about 5 or 6 bulbs in a 6-inch pot. A general potting mixture is best with the addition of enough lime to make the soil slightly alkaline. After planting, water the bulbs sparingly until in growth, then continue with normal watering. Do not keep the soil soggy. The plants thrive in a south window. Because of their straggly growth, they are often used as hanging pot plants.

PALMS

Many palms are easy to grow as house plants. They require only medium light, as in a north, east, or west exposure. Grow them in a general purpose soil mixture and, when well established, feed them every 3 weeks with a liquid fertilizer. Repot palms only when extremely potbound. In the short, dark winter days, growth is slow, hence watering and feeding may be reduced. Palms are grown from seed.

Kentia Palms (*Howea belmoreana and H. forsteriana*)

Kentia palms are native to Lord Howe Island in the South Pacific and this island is the only known place where they will set seed. Kentia palms are often seen at weddings, funerals, parties, and religious ceremonies. As house plants, they are easily grown, but a nice-size young plant is expensive and in about 2 to 4 years has grown too large for most homes.

Phoenix Palms

The best Phoenix palm for house culture is *P. loureiri* (*P. roebelini*), which is a native of Burma. This palm is dwarf and of easy culture, but young plants or seed are rather difficult to obtain.

Date Palm (*P. dactylifera*) is also dwarf and easy to grow. It may be propagated from seeds secured from unpitted dates. Sow the seeds about 1 inch deep in a soil mixture that contains enough sand and peat or leafmould to ensure an open soil. Sow 1 seed in a 4-inch pot, and keep well watered. When the young plant starts to grow it is of a very poor appearance, and it is not until the plant is 2 or 3 years old that it has enough leaves to make it attractive.

PARSLEY

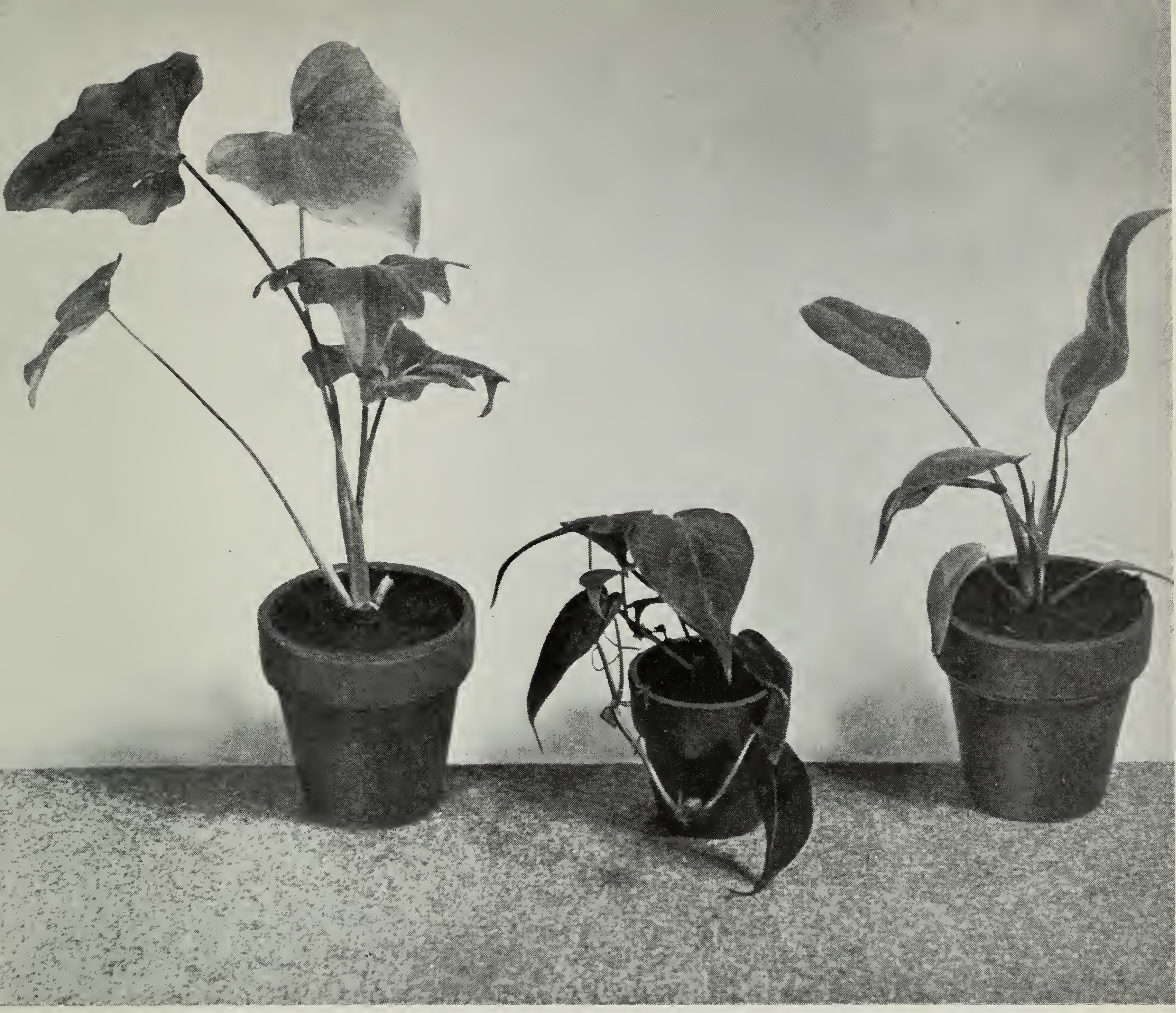
A pot or two of parsley for the kitchen window is not only attractive but is handy for supplying garnishes and for flavoring soups. Sow the seed in a row in the garden. In the fall, dig the plants, and remove all foliage except the two or three central leaves. Plant in a good open soil mixture with the crown just showing above the soil. Give one heavy watering and place the pot in full light in a cool place. When the plant is a fair size, the outer leaves may be removed as needed.

PEPEROMIA

Peperomia (*P. sandersii*) is essentially stemless and has long-petioled, broad, ovate, green leaves with lighter coloured areas resembling a watermelon's stripes. It is propagated by leaf petiole cuttings similar to the African violet. Other peperomia species have branching stems with shiny green or variegated leaves and are propagated by stem cuttings.

All the peperomias require moderate light and if kept a little on the dry

Peperomia sandersii, P. obtusifolia variegata, P. obtusifolia



Philodendron selloum hybrid, P. hybrid, P. micans

side will remain dwarf for some time. The best potting mixture is 3 parts soil, 2 parts organic matter and 1 part sand.

PERIWINKLE

Vinca major, a trailing evergreen with glossy green or variegated leaves and blue flowers, is useful for window boxes. It may be grown in the house in the winter in a cool temperature. To promote more trailing shoots, pinch back the young growth when it is 4 to 8 inches long. Propagation is by cuttings or division. *Vinca rosea* is an erect plant with pink or white flowers. It may be propagated by cuttings or from seed. It is often used as an annual outdoors or may be grown as a conservatory or house plant.

PETUNIA

The large-flowered double petunia is often grown as a house plant, and is sold by some florists as an Easter or Mother's Day pot plant. It may be started by cuttings or from seed. Since the double petunia does not usually set seed, new seed should be purchased each year. This plant needs good exposure to light and a cool temperature; too high a temperature causes bud blast. The double petunia may be planted in the flower bed in the summer; in the fall, before frost damage, take cuttings and root them indoors.

PHILODENDRON

All philodendrons thrive in a north window; some require even less light. They are propagated by cuttings or aerial layering and require a general potting soil. Some will live for long periods in water. They are popular, attractive foliage plants, and often are twisted on supports.

POINSETTIA

Poinsettia flowers are inconspicuous but a colourful show is provided by the large scarlet (sometimes cream) leaf-like bracts. This popular Christmas flowering plant does best with good light exposure and a temperature of about 65°F. Yellowing and dropping of the bottom leaves may be caused by temperatures below 60°F., drafts, and drying out at the roots.

To propagate, make new-growth stem or leaf-node cuttings (up to mid-August), dust with a rooting compound such as Auxan, and root in sand in a warm place in partial shade. On very hot days, syringe the cuttings with water to prevent wilting. When well rooted, dig the cuttings carefully because of their brittle roots. Plant in small pots, using a good general potting soil plus some extra organic matter; increase the pot size as necessary.

If the plants are tall enough and you wish them to branch, pinch the top growth before September 1. Grow at 65°F. Low temperatures below 60°F., sudden changes in temperature, or dry soil will cause the lower leaves to turn yellow, wilt, and drop. If the nitrogen is too low, the plants will be stunted and the top leaves will turn yellow. Feeding with a complete fertilizer every 2 weeks after the plants are established in their pots is a good practice. At the last potting of small plants from late-rooted cuttings, several plants may be put in a 6- to 9-inch azalea pot (3/4 the depth of a standard pot).

Although it is easier and surer of success to buy plants from a florist each winter, plants may be carried over to the next year. After "flowering", rest the plants in a cool location and let the soil dry out. Do not let the stems become so dry as to cause shrivelling of the bark. During this rest period, cut back the plants part way. After the rest period, place the plant in a larger pot, supply water, and expose to good light and a temperature of 65° to 70°F. These plants may now be grown on for Christmas display.

Exposure of the plants to electric light after September 1 should be avoided. It may prevent the flower buds from forming and the bracts from coloring.

PRIMROSE

(*Primula*)

Primroses grow best at 45° to 50°F. Sow the seed (slow germinating) in a very fine soil mixture without peat. Discard the plants after bloom.

Primula obconica has large leaves and very large, showy flowers. It is the easiest primrose to grow, but many persons are allergic to it. A painful skin rash may result from handling it. Best success is obtained in a north window.

The fairy primrose (*P. malacoides*) is smaller in leaf, and plant size than the common primrose and does not cause a rash. A north window is the most suitable location for this plant.

The Chinese primrose (*P. sinensis*) has showy white to dark red flowers and may be double or single. In potting, do not cover the crown of the plant.

RANUNCULUS

The culture of Ranunculus is the same as for Anemone.

RUBBER PLANT

Common rubber plant (*Ficus elastica*) has broad, thick, leathery, shiny, dark-green leaves. A variegated form has pale yellowish areas on the margin of the leaves. The rubber plant is propagated by cuttings or aerial layering. Pinching the terminal growth promotes a branched plant. A general potting soil is suitable. Repot the plant when it becomes potbound. It tolerates shade but thrives better in moderate light.

RUELLIA

Ruellia (*R. devosiana*) is a foliage plant with more or less decumbent stems. The foliage is purple beneath and dark green with white ribs and veins above. The flowers are white with lilac throat and veins. *R. macrantha* is the same as the above but with bright crimson flowers. Ruellia thrives in a warm, moist atmosphere, a soil mixture that is high in organic matter and moderate light.

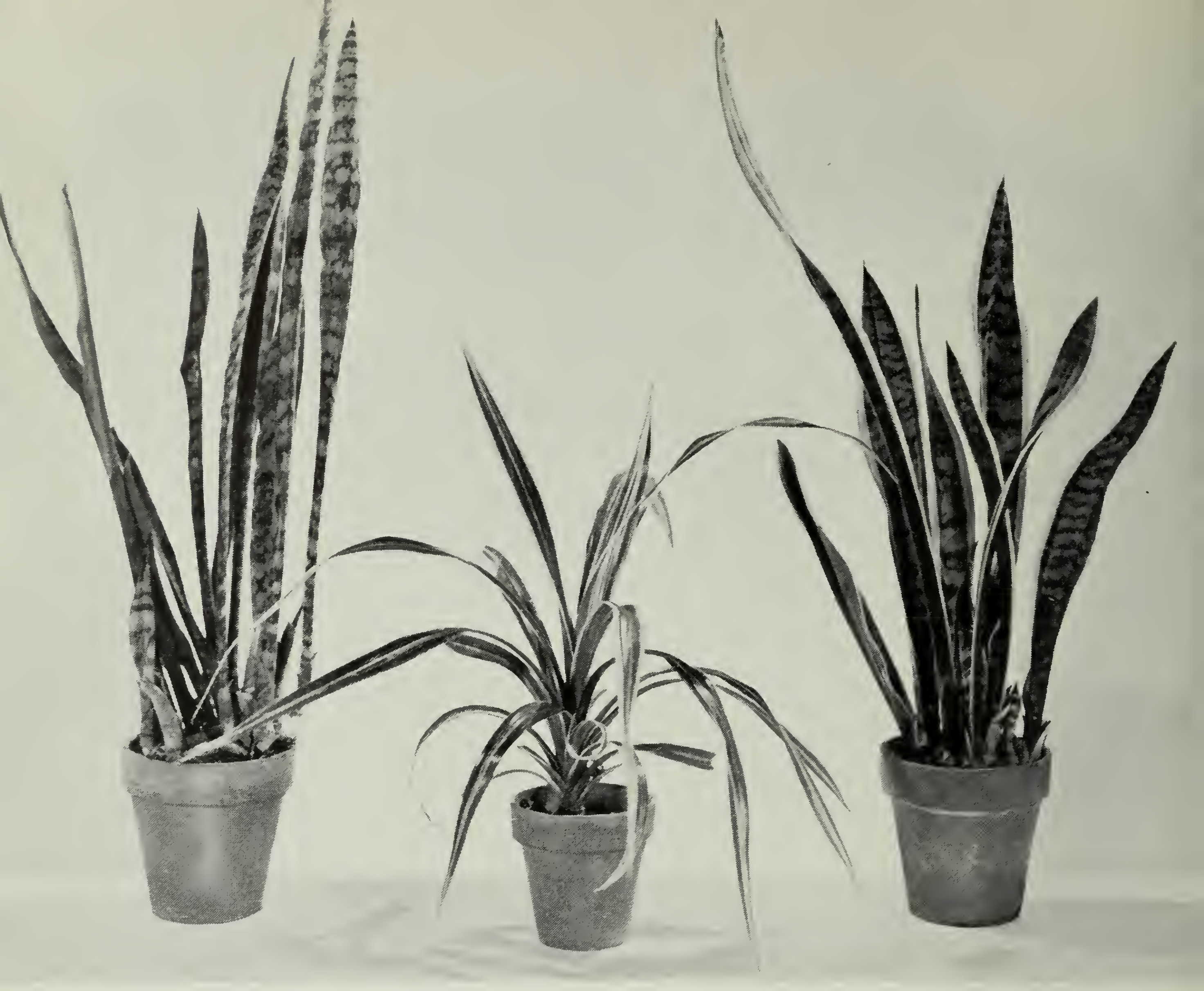
SAINTPAULIA

African Violet

African violet is a very popular house plant. It requires little light and, if not over-watered and otherwise properly cared for, will continue to flower for a long period.

Propagation is by dividing plants with more than one crown or by rooting leaf-petiole cuttings from firm, healthy, mature leaves, in sand or vermiculite. Plant the cuttings shallow because the young plant is formed at the bottom of the petiole and grows up through the rooting medium. The plants tolerate low light, but in winter the light from a north window may not be enough. In late spring and summer, place the plants in a north window or shade from direct sun. A suitable soil mixture is equal parts of soil, sand, well-rotted manure and leaf-mould; peat can be substituted for the manure.

Watering is best done in the morning with lukewarm water. Keep the foliage dry and the soil moist. Too frequent watering may prove injurious. Continual watering from the bottom, such as placing the pot in a dish of water,



Sansevieria, Screw Pine, Variegated Sansevieria

tends to form crystals of soil nutrients on the surface of the soil, which, in time, may become toxic to the plant. Yellow or white spots, circles, or streaks on the foliage are caused by getting the leaves wet when watering or by condensation of moisture from the air due to a sudden drop in temperature. When the plants are established after potting, feed them every 2 weeks with a complete liquid fertilizer.

SANSEVIERIA

Sansevieria (snake plant or bowstring hemp) has long, firm, thick, leathery, swordlike leaves. It tolerates partial shade but thrives best in good light. It is propagated by division or by making cuttings of pieces of leaves. Variety *laurentii* has a band of creamy white on the leaf edges, and must be propagated by division to retain this coloration. *S. cylindrica* has comparatively short, cylindrical green leaves.

SCREW PINE

Screw pine (*Pandanus veitchii*) has variegated green and white, long, shiny, pendulous leaves that are arranged spirally. The edges of the leaves have small, very sharp ascending spines. The plant is a fairly rapid grower, requiring medium light and high temperatures, and should be kept from drafts and never put out in a cold rain. It requires plenty of water, but water should not be poured into the base of the leaves; it will tolerate a fairly dry atmosphere. Variegated leaves are likely to give place to green if the soil is too fertile. The plant tends to push out of the soil on long prop-like roots as it grows larger. This may be overcome, for a time, by removing some of the roots from the bottom and repotting the plant a little deeper. To propagate, root the small sucker growth in sand.

SILK OAK

The silk oak (*Grevillea robusta*) is a tree with fern-like leaves that are silky on the underside. It makes a very good house plant until it attains the height of 4 to 5 feet. Then it becomes ragged and unkempt in appearance and should be discarded. It is easily propagated from seed.

SWEETPOTATO

The sweetpotato (*Ipomoea batatas*) is often used as a house plant and makes an attractive trailing or trellis vine. To find the top of the tuber lay it in moist moss in a warm place until growth starts. Place this tuber in a jar or bowl of water containing pieces of charcoal so that the top of the tuber is above water. Kiln-dried sweetpotato roots will not produce growth.

UMBRELLA PLANT

The umbrella plant (*Cyperus alternifolius*) has long stems with long, narrow leaves at the top of the stems, thus forming the so-called umbrella effect. Propagation is by division of the root or by leaf-stem cuttings. To make these cuttings: cut the stem just below the leaves; trim the leaves back to 4 inches long; place in water so that the base of the leaves are covered. New young plants arise in the axils of the leaves.

The umbrella plant is potted in a general soil mixture and requires plenty of water. Sometimes this plant is grown in a pool with the pot completely under water. If some stems become very shaggy or infested with mealy bug, they may be removed without injury to the plant.

WANDERING JEW

Wandering Jew or spiderwort has green variegated or purplish leaves. Cuttings will root in water, and stems may be grown in water for months. The plants thrive in a general soil mixture, with plenty of water, good light, and cool moist air; but they may do fairly well in poor light, dry air, and a high temperature. The tips of the stems may be pinched to prevent long stems and to cause branching.

WAX PLANT

The wax plant (*Hoya carnosa*) is a flowering vine with thick, leathery, waxy leaves. The flowers are flesh-coloured, fragrant, and star-shaped. To propagate, root stem cuttings in sand. Since the root system is small, first use small pots and then repot to a little larger size only when the root growth warrants it. This plant thrives in a warm, sunny place.

ULLETIN 508 MAY, 1955

PLANTS POISONOUS TO LIVESTOCK

ONTARIO DEPARTMENT OF AGRICULTURE
PARLIAMENT BUILDINGS, TORONTO, CANADA

BULLETIN 508 APRIL, 1955

PLANTS POISONOUS TO LIVESTOCK IN ONTARIO

by

F. H. MONTGOMERY
Professor of Botany
Ontario Agricultural College

DR. J. A. HENDERSON
Head. Dept. of Medicine and Surgery,
Ontario Veterinary College

DR. R. O. BIBBEY
Professor of Botany
Ontario Agricultural College

ONTARIO DEPARTMENT OF AGRICULTURE
PARLIAMENT BUILDINGS TORONTO, CANADA

Plants Poisonous to Livestock in Ontario

INTRODUCTION

From the frequent requests for information on poisonous plants, it is evident that knowledge concerning these plants should be more readily available to those vitally interested. It is the purpose of this bulletin to describe in a simple manner and to illustrate Ontario plants that are known to be poisonous or injurious to animals, and also those suspected of being the cause of poisoning. In this way stock raisers may become familiar with harmful plants and take precautions not to expose their animals to them. The bulletin is also intended to give assistance in diagnosing symptoms of poisoning by the plants described. The ability to diagnose the sickness and to determine the origin or type of poisoning is often important in saving the life of a valuable animal.

In cases of poisoning, few people have the necessary remedies available or the facilities for compounding and administering them. For these reasons remedial measures are not given in detail, and it is recommended that the services of a veterinarian be obtained when poisoning is suspected.

As far as possible the authors have drawn on their personal observations and experience, but these have been supplemented by information secured from many sources. The more important references are acknowledged on page 34.

The sequence of plants follows that of Gray's Manual of Botany (1950) and the scientific names are those used in the Manual. The common names are those which seem to be most frequently accepted in manuals and bulletins, and no attempt has been made to include the many other more local names.

GENERAL REMARKS

It would simplify matters greatly if plants could be classified into two groups, poisonous and non-poisonous. Unfortunately this cannot be done, for many factors are responsible for the toxic principles in plants, and what may be a harmless species of plant on one occasion, or in one place, will be deadly at another time or in another locality.

Individual species vary greatly in their poisonous content from early growth to maturity and seed production. Cocklebur, *Xanthium* spp., is poisonous in the seedling stage, but later is considered to be harmless. Young sorghum plants contain more prussic acid-forming materials and are more harmful than mature plants.

The state of the plant when eaten is important. Wilted or damaged sorghum plants contain prussic acid that is not present in that chemical form when the plants are in a fresh condition. Sorghum with stunted growth or touched by frost is a serious source of poisoning. Drying of the plants often reduces or eliminates the poisonous properties which they contain.

Certain parts of a plant may be poisonous and others not; for example, the blade of the rhubarb leaf is poisonous, while the leaf-stalk is not. The seeds of corn cockle *Agrostemma githago* L., and bouncing bet, *Saponaria officinalis* L., are considered to be the most toxic part of the plants.

Climatic conditions such as temperature, moisture, and light contribute greatly to the variability in the poisonous properties of plants; and in conjunction with climate, the season of the year may be a determining factor.

The composition of the soil produces important chemical characteristics in plants. High nitrogen in the soil causes some plants under certain conditions to accumulate nitrates, and these, often during the process of digestion, are changed by bacterial or enzyme action into poisonous nitrites. Nitrates in the soil will also affect the quantity of prussic acid forming substance contained by certain plants. However, the advantages of nitrogen to the soil far offset any disadvantages that may result from the damage caused by relatively few plants.

Geographical distribution may be related to soil factors. Selenium, which is found in the soil of several of the western states and parts of the prairie provinces, is absorbed by several plants, and constitutes a serious source of poisoning in these regions. In Ontario, this type of poisoning is unknown since selenium is not a significant part of our soil composition. Also, plants may be poisonous in one geographical area and not in others. This is probably the case with black nightshade.

Different farm animals are susceptible to different plants and different poisons. Pigs might feed without injury on one plant species, while cattle would die if they ate the same species. The age of the animal is also an important factor. Young animals may be susceptible to certain poisons, while adults will be unaffected, and vice-versa. Animals may build up a resistance to certain poisons by eating small quantities, and then when exposed to large quantities may not be affected. An animal that is hungry, or has certain dietary deficiencies, is more likely to eat toxic quantities of a poisonous plant than a well-fed animal; the latter will be more selective in what it eats.

Constant feeding on one kind of fodder or plant may also cause serious consequences, since many poisons are cumulative in their effects. The plants may be fed for weeks before their poisonous ingredients affect the animal. The bracken fern, horsetails, and spoiled sweet clover are examples of cumulative poisoning.

Flowering plants are not the only members of the plant kingdom to produce injurious results. The lowly fungi are important, particularly in their effect on silage. They may cause chemical changes in the silage which make it poisonous, or they may be poisonous in themselves. Mouldy sweet clover silage is a probable example, and should be fed with great caution. Ergot is one well known fungus that has been responsible for many animal deaths. The pond scums (blue-green algae) in the water of ponds or sluggish streams are also known to cause animal poisoning, particularly during the drier summer months.

CLASSIFICATION OF POISONOUS PLANTS

There are several systems of classification, each of which has its own particular advantage or disadvantage. Since most plants contain more than one poisonous ingredient, it is impossible in most classifications to segregate a plant into any one group, and overlapping occurs frequently. Consequently, one could continue indefinitely listing plants according to their chemical content or physiological effect.

The following is a general classification according to chemical composition of the poisonous principle:

1. Alkaloids—These are relatively complex nitrogenous compounds which are produced by plants, and many are extremely poisonous, e.g. strychnine. Members of the poppy, buttercup, honeysuckle, potato, legume, and dogbane families are noted for their alkaloid content.
2. Glucosides—A glucoside is a substance which furnishes a sugar or sugars, and one or more other products on certain chemical reactions. In a plant, an enzyme is often secreted in the same tissue as the glucoside but in different cells. When

the cell walls are broken by some kind of injury the enzyme comes in contact with the glucoside and produces the poisonous substances. Glucosides are divided into several groups. Three important ones are given:

- (i) Cyanophoric glucosides yield prussic acid in certain chemical reactions, e.g., cherry leaves, vetch, sorghum, flax.
- (ii) Mustard oil glucosides are found chiefly in the mustard family, e.g. black and white mustard, *Brassica* spp., peppergrass, *Lepidum* spp., rape seed.
- (iii) Saponin glucosides are distributed chiefly in the roots, leaves, and seeds of plants, e.g. foxglove, *Digitalis*, bouncing bet, *Saponaria officinalis* L., dogbane, *Apocynum* spp.

3. Poisons which act only when an animal is exposed to bright sunlight—St. John's-wort, *Hypericum perforatum* L., buckwheat, *Fagopyrum* spp., and some clovers, *Trifolium* spp., contain certain substances that cause the unpigmented skin of animals to become sensitive to sunlight. In these animals the unpigmented skin becomes inflamed, sore and swollen, and the skin may peel. In some cases the disease becomes acute.
4. Inorganic compounds—Selenium may be taken up from the soil by certain plants, but this is not known in Ontario. Nitrate poisoning does occur. Here, the nitrates taken up by the plants are broken down into poisonous nitrites. Molybdenum may also be taken from the soil by plants, and chronic molybdenum poisoning has been reported in certain counties of Eastern Ontario.
5. Oxalic acid—Leaves of rhubarb, some docks, sheep sorrel, *Rumex* spp., and sorrels, *Oxalis* spp., are known to be high in oxalic acid.
6. Resinoid compounds—These occur in members of the heath and the parsnip families.

A second classification might have been based on the physiological actions of the poisons. Some may act as blood poisons, while others are nerve poisons; some affect muscular action, while still others may be irritant or corrosive in their action.

PREVENTION OF POISONING

There are a number of obvious measures that may be taken to avoid losses from the poisoning of livestock. Ideally, if the poisonous plants could be eradicated, these losses could be prevented. However, eradication may not be economically feasible. If not, the area should be pastured with care, a close watch being kept for symptoms or habits of livestock that might indicate plant poisoning. Field observation will also indicate if the poisonous plants are being grazed in quantity. The risk to animals pasturing near plants as deady as water hemlock, however, is so great that either the weed must be eradicated or the livestock fenced from the infested area.

It must also be recognized that some growth condition may cause some normally valuable crop plants to become poisonous. To avoid this development they must be given the conditions under which they grow best, and they must be harvested or fed in such a manner that they will not form toxic substances.

Why an animal starts to eat poisonous plants that it previously has avoided is not known. We do know that livestock with insufficient salt, or with nutritive deficiencies, have abnormal appetities, and may be expected to explore the feeding value of plants. Likewise, when there is a lack of palatable forage on the pasture, the animals may graze on less desirable species. This is often the case when animals eat young water hemlock plants in early spring or fall. Moreover, weed control workers have found that livestock concentrate on herbage treated with 2,4-D. They warn, however, that poisonous species, if sprayed and not killed, may also become more palatable and a menace. A hungry animal is not as likely to be as selective in its diet as one that has already had the keen edge of its appetite satisfied. Sheep-men often allow their animals to fill up on good range before the sheep are taken through territory infested with poisonous plants.

The following summarizes certain management practices that will help to avoid livestock losses:

1. Keep animals well supplied with salt and other nutritive supplements.
2. Maintain good pasturage and do not over-graze.
3. Eradicate or fence in the more troublesome poisonous plants.
4. Observe the precautions necessary to avoid bloat, etc., from the pasturing of clovers.
5. Watch for spoilage of hay and other food materials such as silage.
6. Learn to recognize potentially poisonous plants. If poisonous plants are present watch for evidence of their being grazed, for symptoms of poisoning, or for unusual habits of livestock.
7. Woodlots and swampy areas contain most of our native poisonous plants. It is also recognized that they are very unsuitable for pasturage from the standpoint of quantity and quality of food. Woodlots are much more valuable for development of timber, and swamps are our best reservoirs for water supplies. Two aims may be accomplished at once by keeping animals out of these areas: first, protection of the animals, and second, conservation of woodlots and swamps.

NITRATE POISONING

Several plant products, of which the most common are oat hay and straw, may contain nitrate in potentially toxic amounts. Under the influence of moisture, and possibly other factors, nitrate is changed to nitrite either previous to feeding or in the digestive tract of the animal; thus, oat hay, while normally harmless, may be dangerous when fed wet. Other feeds which have been shown to be capable of causing nitrate poisoning include sugar-beet tops, cooked mangolds, barley hay, and wheat hay. Drought or other adverse conditions, including 2,4-D treatment, may raise the nitrate content of a plant above the toxic level.

Actual poisoning is due to the interference by the absorbed nitrate with the transfer of oxygen by the blood; the animal actually dies of suffocation. Most cases of poisoning have occurred in cattle, but other animals are susceptible.

Symptoms: The symptoms exhibited by affected animals include rapid pulse and respiration, weakness, staggering, and muscular tremors. The animal soon sinks to the ground, gasps for breath and dies without struggling. If the blood is examined it will be found to be brownish in colour rather than red, and will turn a lighter colour on exposure to the air. Those pregnant cows which recover may abort within a few days.

Treatment: Professional assistance should be obtained immediately. Prompt recovery follows the administration intravenously of methylene blue in 2% solution. A dose of 25 to 50 cc. of this solution appears sufficient for a 500 pound animal. Occasionally a second treatment may be necessary.

Prevention: Until more is known about the conditions promoting the storage of nitrate in plants and its subsequent conversion to nitrite, recommendations for prevention of nitrate poisoning must be incomplete. It is suggested, however, that care be taken in feeding any of the above mentioned plant materials, particularly oat hay if it has been moistened. If the oat crop has suffered a setback during the later stages of growth, it should also be used judiciously. Sugar-beet tops are also thought to be particularly dangerous if allowed to lie around in piles for some time after harvesting. Ragweed, wild sunflower, Russian thistle, nightshade, Canada thistle, and spiny sowthistle are also suspected of causing nitrate poisoning.

ALGAE IN WATER

Water in stagnant ponds or lakes may contain plant organisms called algae, which, directly or indirectly, are capable of poisoning livestock. It has not been defintely determined whether the algae itself is poisonous, or whether the by-products and accompanying organisms are responsible for the poisonous nature of the water. Not all species of algae are poisonous, and the common "pond scum" found on stagnant ponds in the summer months is usually harmless. The blue-green algae are the group generally thought to be responsible for loss of animals. Long periods of warm weather and a high content of organic matter in the water favour the concentration of poisonous algae.

Changes in the direction of wind may transfer the toxic substances from one locality to another, causing poisoning in widely separated sites and making it difficult to trace the point of origin of the algae.

Symptoms: As a general rule, symptoms develop very rapidly. Under experimental conditions death has occurred in a cow within twenty minutes after drinking affected water. Animals may be found dead at the water's edge, or after having walked a few rods. Convulsions may occur, but more frequently the animal sinks to the ground, and dies without struggling. Smaller amounts of poison cause weakness and staggering, followed by recovery.

In some instances, apparent recovery from an attack is followed in a few days or weeks by evidence of photosensitization (see St. John's-wort p. 21). There may be inflammation of the muzzle, the skin of the ear, the udder, or other parts of the body. Jaundice is often seen, and constipation is a common symptom. Such cases usually recover under good care.

Treatment: Professional assistance should be procured immediately. Although no specific treatment is known, intravenous injections of sodium thiosulphate and methylene blue have been used successfully in acute cases. Skin lesions may be treated with a healing oil, and it is very important that the animals be provided with shade.

Prevention: During July and August, when these algae are likely to become abundant in stagnant or slow moving water, sources of drinking water should be examined periodically for the presence of blue-green algae. If observed, care should be taken to have such water fenced off or chemically treated before animals are allowed into adjacent pasturage.

Treatment of the water with copper sulphate is recommended. Care must be exercised in the use of this chemical, or poisoning by it may result. The use of 3 pounds of copper sulphate to one million gallons of water has been recommended. An estimate of the volume of water to be treated should be made, then the required amount of copper sulphate tied in a cloth bag and dragged through the water in such a manner as to insure an even distribution of sulphate throughout the whole body of water.

ERGOT, *Claviceps* spp.

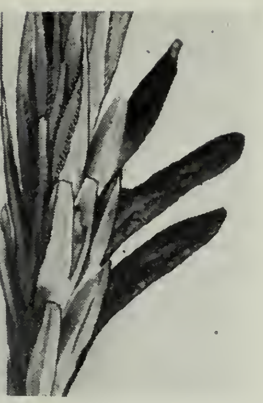


Fig. 1. Ergot of Rye.

The best known variety of this fungus is the one which infests rye and is commonly called "Ergot of rye." (Fig 1). However, it is also found on other species of grasses. It is observed as hard, dark-coloured masses in the fruiting spikes or panicles of grasses. It appears in the grass flower and might be mistaken for a seed, although it is usually much larger, and black or dark grey.

The following are some of the crop, pasture, and wild grasses on which ergot has been reported to occur:

Quackgrass	*Agropyron repens* L.
Red Top	*Agrostis alba* L.
Bent grass	*Agrostis stolonifera* L.
Meadow foxtail	*Alopecurus pratensis* L.
Oats	*Avena sativa* L.
Brome grasses	*Bromus* spp.
Bluejoint grass	*Calamagrostis canadensis* (Michx.) Beauv.
Orchard grass	*Dactylis glomerata* L.
Oat grass	*Danthonia spicata* (L.) Beauv.
Hairgrass	*Deschampsia caespitosa* (L.) Beauv.
Wild-rye	*Elymus canadensis* L. and *E. virginicus* L.
Fescue grasses	*Festuca elatior* L., *F. ovina* L., *F. rubra* L.
Manna grasses	*Glyceria* spp.
Barley	*Hordeum* spp.
Bottlebrush	*Hystrix patula* Moench
Canary grasses	*Phalaris arundinacea* L. and *P. canariensis* L.
Timothy	*Phleum pratense* L.
Blue grasses	*Poa* spp.
Foxtail grasses	*Setaria* spp.
Wheat	*Triticum* spp.
Rye	*Secale* spp.

When eaten in sufficient quantities, Ergot is poisonous to all domestic animals and poultry. The active principle, *ergotoxine*, stimulates the nerve centres that cause contraction of the small blood vessels supplying the different parts of the body. The result of ergot poisoning depends largely upon the amount of the fungus consumed. When only small quantities have been taken in, recovery without any serious symptoms may take place; where large quantities have been consumed, death, dry gangrene in the extremities, and possible abortion in pregnant animals may result.

Symptoms: General symptoms such as lack of appetite, dullness, abdominal pain, and sub-normal temperature are common. Two distinct types of symptoms may develop in severe cases; (a) nervous, (b) gangrenous.

(a) Nervous form:

Dullness and depression are evident. There may be muscular trembling, convulsions, contractions of the legs, and delirium. The animal suffers from gastro-intestinal catarrh, refuses food, and gradually develops a wasting condition. A very rapid type is sometimes seen in which the animal may die in spasms or convulsions.

(b) Gangrenous or general form:

The stoppage of blood due to the contraction of the small blood vessels causes necrosis (death) of the extremities, particularly the feet, the tail, or tips of the ears. The affected part is cool, and dries up; a small furrow or line of separation appears, completely surrounding the limb and dividing the living tissues from the dead. There is little or no loss of blood, and seldom any pus present. As well as from gangrene, death may also occur owing to the invasion of bacterial organisms, "secondary invaders." Cases that do recover may be crippled for life. Antiseptic treatment of affected parts and general symptomatic treatment may be of benefit.

Prevention: Remove all food and bedding that might contain ergot. Seed grain should be thoroughly cleaned and treated before being sown. Any crops or hay heavily contaminated with ergot should not be considered suitable as food for animals. Haylofts or bins that have housed ergotized material should be cleaned before new hay or grain is placed in them.

BRACKEN FERN

Pteridium aquilinum* (L) Kuhn. subsp. *latiusculum* (Desf.) Underw. ex *Heller. (Fig. 2).

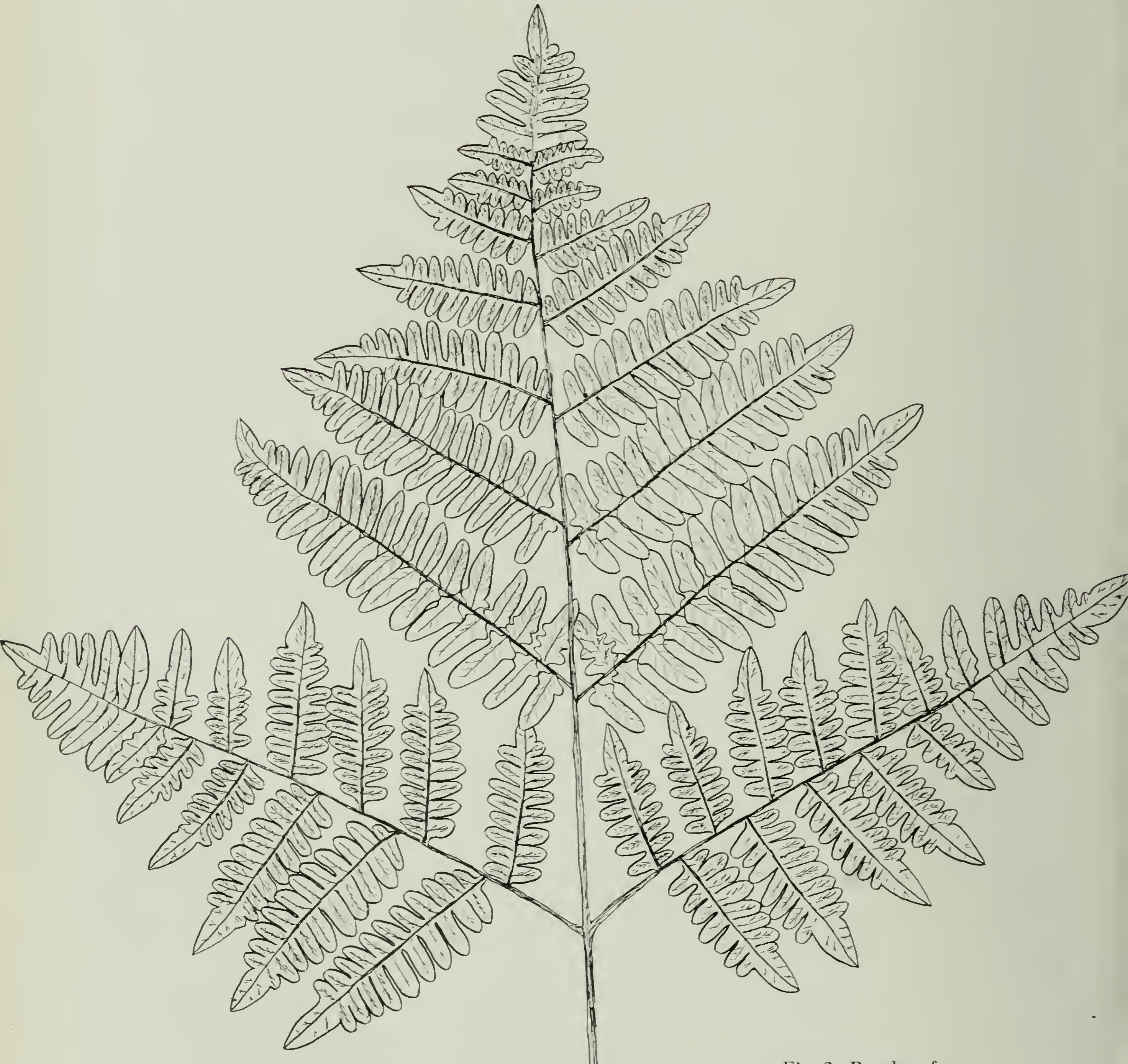


Fig. 2. Bracken fern.

This sub-species of the bracken is widely distributed in eastern Canada, and may have a wide range of habitats. It will grow in open fields, woodlands, low ground, or dry rocky soil. Under normal conditions it is not usually important in livestock poisoning as animals do not find it particularly palatable; but in seasons when pasturage may not be good, animals will feed upon it. Poisoning by this plant is reported in horses, cattle, and sheep, and both young and mature animals may be affected.

Poisoning by the fern does not become evident for some time, probably weeks after the plant has been eaten, and it is often difficult to trace the cause of poisoning to bracken. In horses, continuous feeding on bracken for at least two weeks is necessary to produce symptoms. Poisoning in horses appears to be due to the presence of a substance in bracken which destroys *thiamine* (vitamine B). This substance appears to be more abundant in the growing plant than in the mature plant. The exact cause of poisoning in ruminants is unknown.

The plant has a dark, wide-spreading underground stem from which the above ground structure rises. The frond (leaf) may become 3 to 4 feet high, and its best distinguishing feature is its three-branched appearance (Fig. 2). It is dark green, and the stem is glossy brown. The margins of the many divisions of the frond are rolled toward the under side, and in these rolled edges are produced the spores from which new plants develop.

Symptoms: The principal symptoms in horses are loss of flesh, jaundice, staggering gait, weakness progressing to paralysis, and sometimes a degree of excitement. The temperature remains normal and the appetite, while depressed, is not lost until the later stages.

The symptoms exhibited by cattle and sheep bear little resemblance to those found in the horse. A high fever is usually observed, along with laboured breathing and drooling from the mouth. Haemorrhages may be seen in the nostrils, and blood is often observed in the urine and faeces. The patient may die in convulsions, and a post-mortem examination reveals extensive haemorrhages throughout the body.

Treatment: When the first symptoms are noted a veterinarian should be called. Animals should be removed from infested pastures, or the feeding of hay containing bracken discontinued. Laxatives in the form of oils may be administered and good hay fed. Yeast, an excellent source of thiamine, may be fed mixed with oats to counteract the deficiency in horses. Thiamine injections are also advised. There is no specific treatment for the diseases in cattle, although blood transfusions and supportive treatment are somtimes of benefit.

HORSETAILS, *Equisetum* spp.

Horsetails (Fig. 3) are usually abundant in soil that has poor drainage, and they are particularly common in low, sandy, and acid soils. The plant has a creeping, branching, underground stem which produces two structures above the ground. In the early spring a yellowish-brown spore-producing branch appears (Fig. 3A), and from these spores new plants will develop. This branch dies off after shedding the spores and is succeeded by a green, bushy, vegetative structure (Fig. 3B). The stems are ridged, and contain a gritty, sand-like material.

Horsetails are often found in hay from low or sandy land and may be a source of trouble in the winter. Hay of unknown origin should be examined for this plant.

Like bracken, the action of the poisonous principles of horsetails is cumulative, and its effects may not be seen for some time after the animal has fed on the plant; in fact, the poisonous principle appears to be identical — a thiamine deficiency. Horses, particularly young horses, are most susceptible, although poisoning has been reported in cattle and sheep.

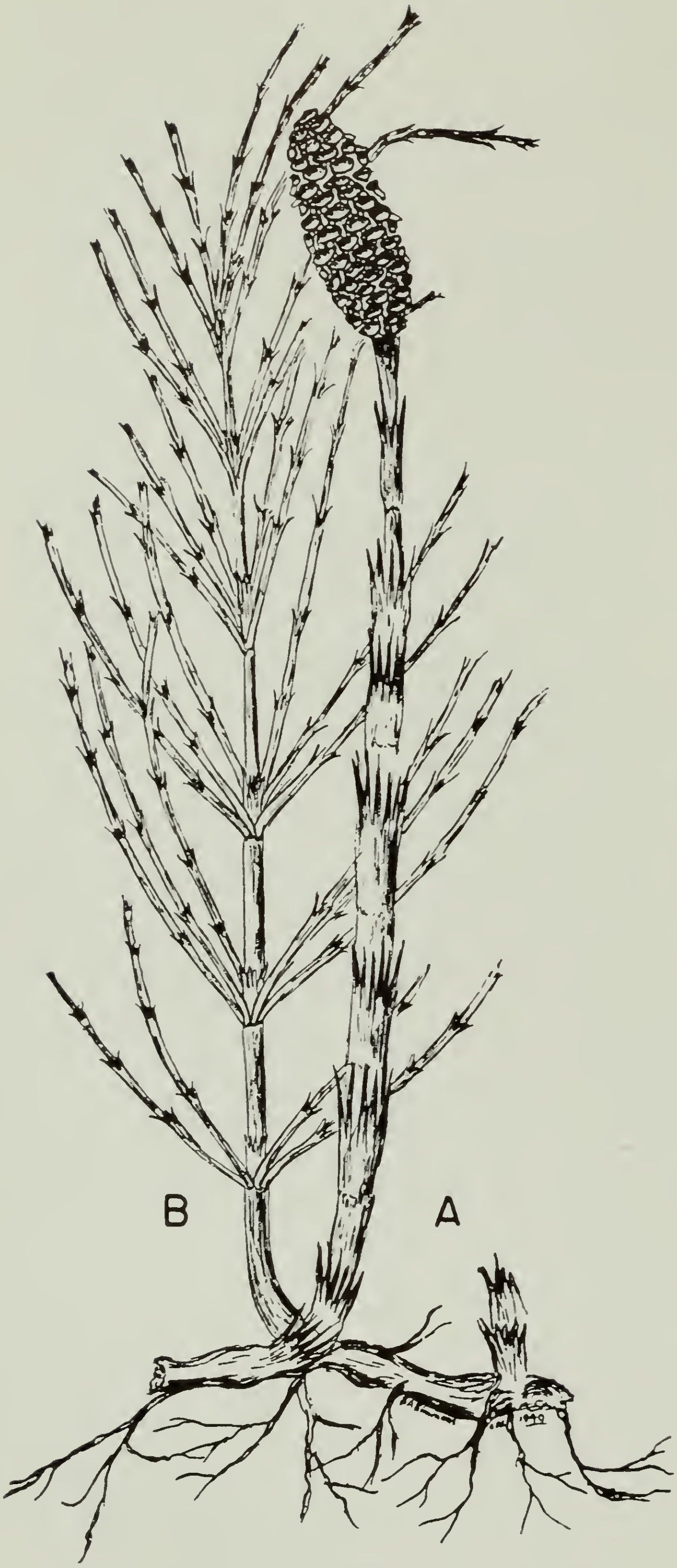


Fig. 3. Field horsetail.
A, Spore producing branch. B, Vegetative branch.

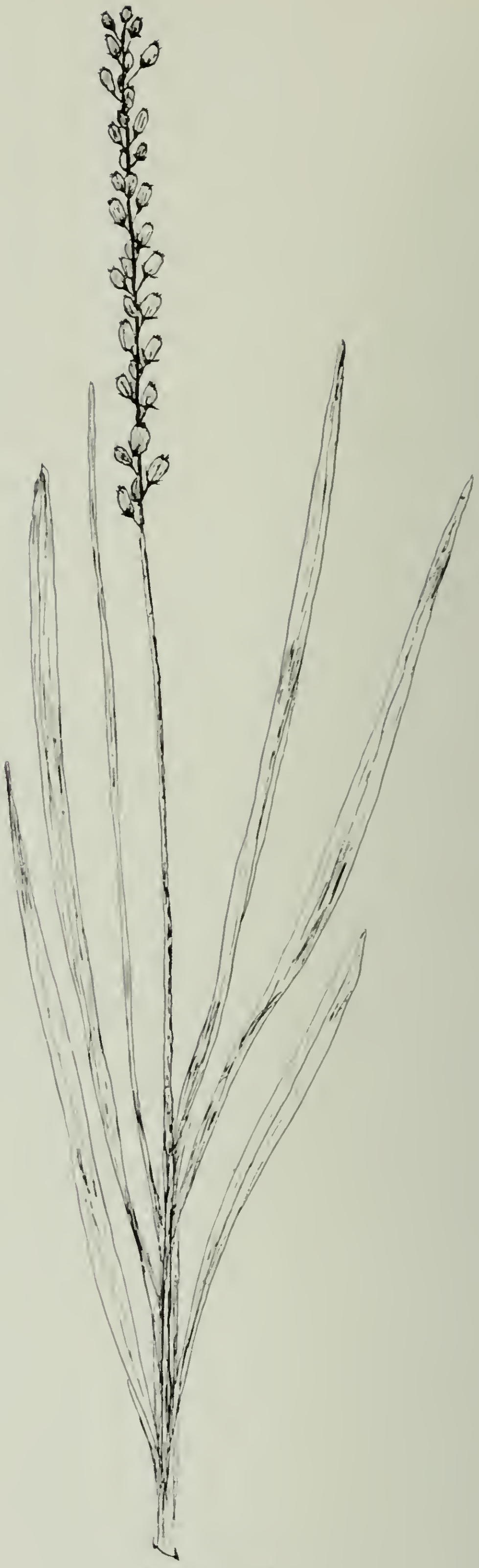


Fig. 4. Marsh arrow-grass.

Symptoms and Treatment: The symptoms resemble closely those found in bracken poisoning in horses, and treatment should follow the same lines. Thiamine, either in the feed or by injection, will bring about recovery except in some advanced cases.

MARSH ARROW-GRASS, *Triglochin maritima* L.

Marsh arrow-grass (Fig. 4) grows in marshes or in moist soil high in alkali. The grass-like leaves arise from the rootstock, and the long, leafless, flowering spike bears many small, greenish flowers. Fortunately the plant is not common in Ontario where stock is likely to graze, and poisoning does not occur frequently. The plant in both the green and dry state contains hydrocyanic (prussic) acid in a complex chemical form. When the plant is eaten, the acid is liberated by the action of an enzyme.

Symptoms: Hydrocyanic acid acts very quickly, symptoms often appearing within 10 minutes following the ingestion of toxic plants. It poisons through interference with respiration, and thus one of the first symptoms is an increase in the breathing rate. Breathing soon becomes difficult, and the animal goes down with the head turned to one side and the pupils dilated. The breath has a characteristic almond odor. Death usually occurs within an hour unless treatment is administered.

Treatment: Professional assistance is required. Intravenous injections of sodium thiosulphate and sodium nitrite in solution are effective even in severely affected animals. Drenching the animal with sugar or corn syrup may be of value.

CORN STALK POISONING

This condition has not been of major importance in Ontario, although it has caused heavy losses in the north-central United States. Poisoning has been reported only in cattle. It occurs when cattle feed in the field on corn stalks which have been stunted or frozen before maturity; it rarely occurs when the stalks are cut and fed in the barn. Young cattle are most susceptible. The toxic agent has not been identified, but it is neither hydrocyanic acid nor nitrate, nor has a mould been found in the poisonous stalks.

Symptoms: Symptoms may develop a week to ten days after turning cattle into a field in which corn stalks have been affected. Dullness and listlessness are noticed first, followed by constipation, drooling of saliva, and paralysis of the throat. The animal generally sinks into a coma, although on occasions convulsions may precede death. The course of the disease is usually less than 48 hours.

Treatment: Laxatives and supportive treatment have been tried, and may be of some benefit, but the death rate is high. The services of a veterinarian should be secured.

MOULDY CORN POISONING

Mouldy corn has been shown to be capable of causing poisoning in both horses and swine. It can occur either when corn fields are grazed or when mouldy corn is fed in the barn. The toxic mould has not been identified, but it is known that only some types of mould which grow in corn are capable of causing poisoning.

Symptoms: Symptoms in horses occur after the affected corn has been fed for several weeks. Typical symptoms include dullness, blindness, walking in circles, jaundice, and progressive paralysis. Death usually occurs within two days.

The disease in swine bears no resemblance to its counterpart in horses, the only common factor being the feeding of mouldy corn. It appears in growing pigs, particularly in females, and takes the form of a marked swelling and inflammation of the external genital organs.

Treatment: No treatment has proved effective in this form of poisoning in horses, although some early cases have recovered following withdrawal of the affected corn and the administration of a laxative. Swine recover gradually following a change of feed. Again, professional advice should be secured.

SORGHUMS, *Sorghum* spp.

Johnston grass, *Sorghum halepense*, sorghum, *Sorghum vulgare*, and Sudan grass, *Sorghum vulgare* var. *sudanense* under certain conditions cause stock poisoning. They may prove dangerous if they have been grown under adverse conditions, such as drought or poor soils, and if they have been affected by frost.

The poisonous principle is hydrocyanic acid, and the symptoms and treatment are given under march arrow-grass p. 10.

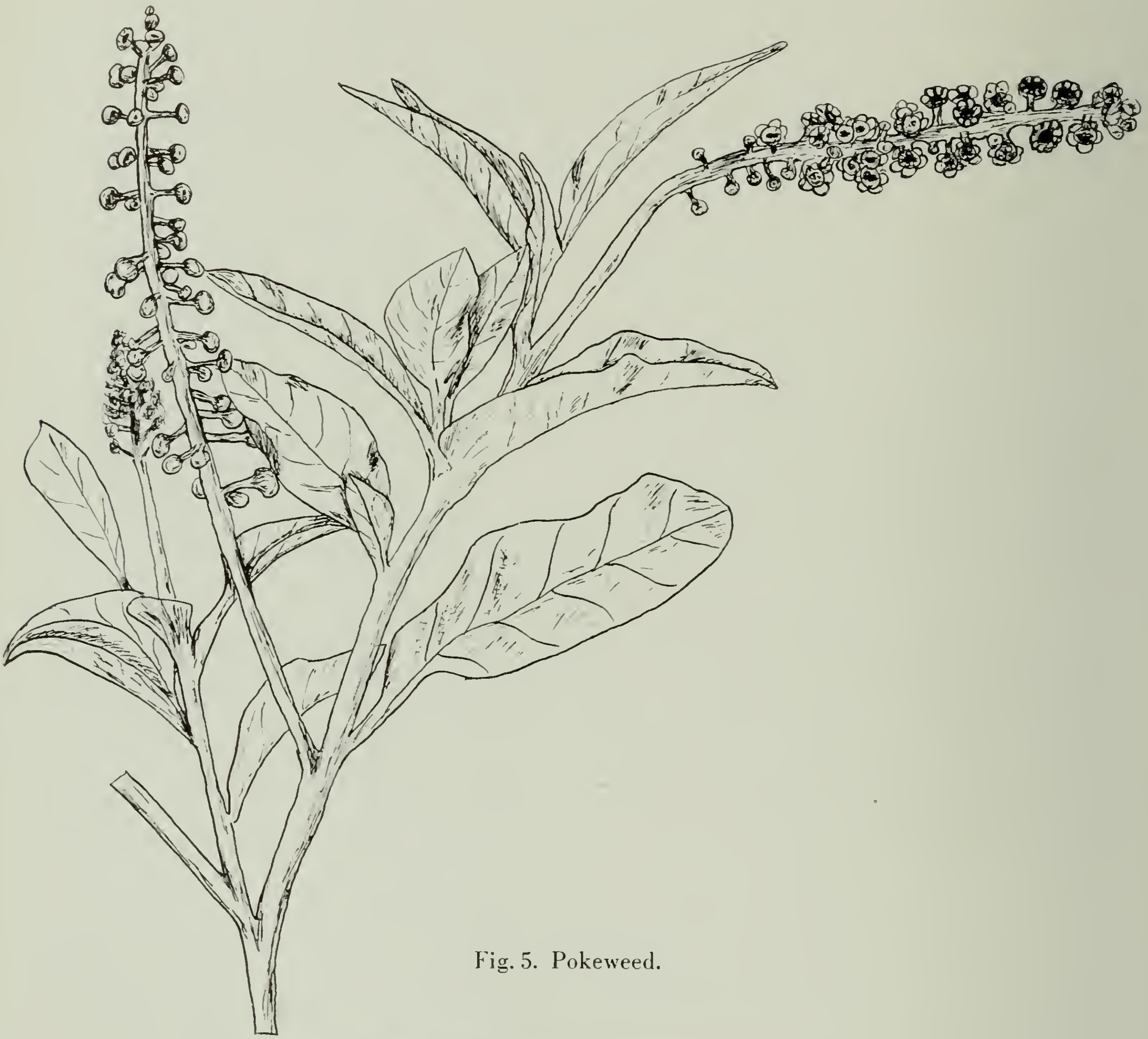


Fig. 5. Pokeweed.

POKEWEED, *Phytolacca americana* L.

This plant (Fig. 5) has a perennial, large, rather ridged root, and a tall, thick, smooth stem. The alternate leaves are large, short-stalked, and smooth-margined. There is a dense raceme of small white flowers. The fruit turns deep purple as it matures, and forms a circle inside of the purple calyx. It is found most frequently in southwestern Ontario although it is known to occur in localities along Lake Ontario, the St. Lawrence River, and Georgian Bay.

The roots and young plants are considered poisonous to livestock.

Symptoms: The poisonous agents, among which are *phytolaccotoxin*, *phytolaccine*, and *saponin*, are violent but slow-acting emetics. Vomiting may not appear for two hours or more after eating the plant. Large doses affect muscles and nerves, producing retching spasms, purging, and sometimes convulsions. Death usually results from paralysis of respiratory centres. Cattle appear to be most susceptible.

Treatment: Professional advice should be obtained as soon as symptoms are noted. There is no specific treatment, but laxatives and symptomatic treatments are of value.

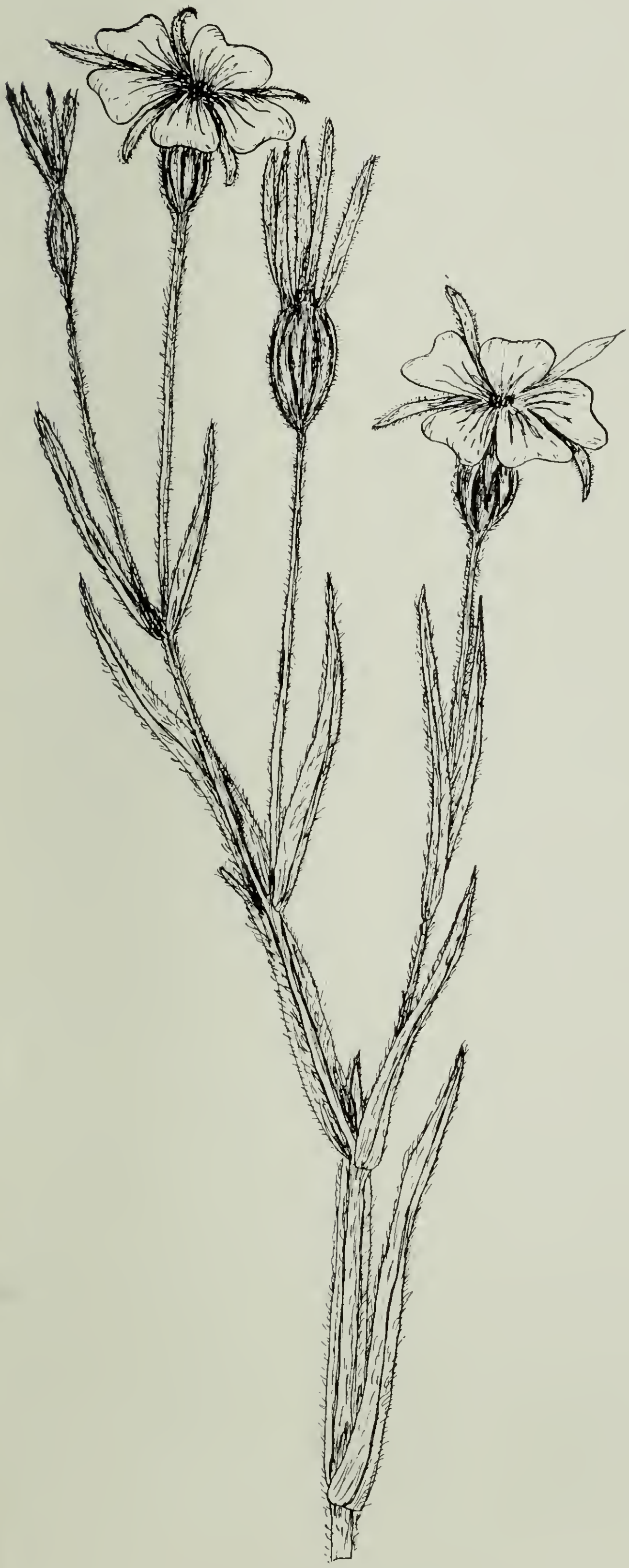


Fig. 6. Purple cockle.

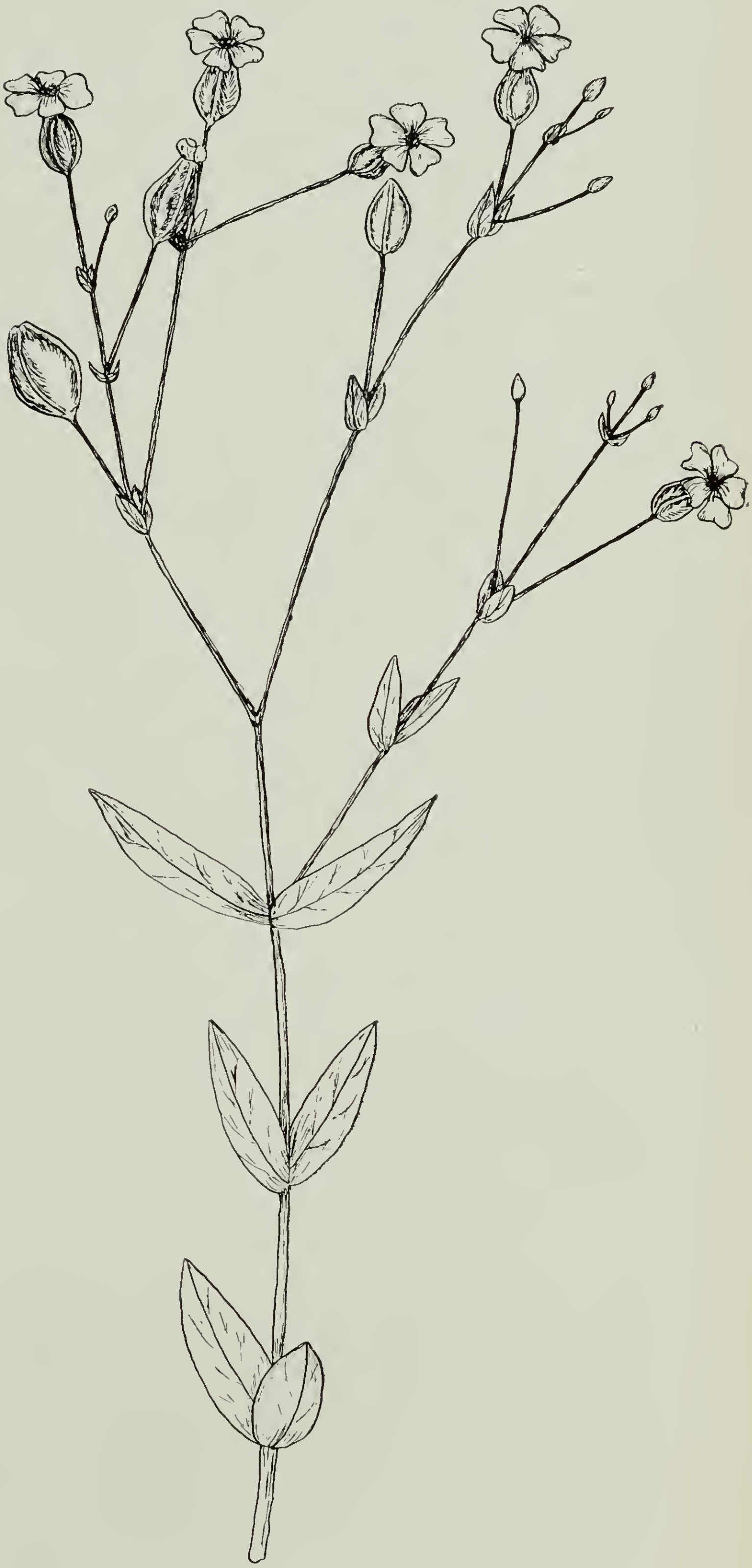


Fig. 7. Cow cockle.

THE COCKLES

The seeds of the cockles contain glucosides, one of which is *saponin.* Poisoning has resulted when these seeds have been included in grain fed to poultry, or in ground grain fed to other animals.

Three cockles are frequent-to-common in Ontario: purple cockle, *Agrostemma githago* L. (Fig 6); cow cockle, *Saponaria vaccaria* L. (Fig. 7); and bouncing-bet, *Saponaria officinalis* L. (Fig. 8).

Purple cockle is a winter annual with tall branching stems covered with whitish, silky hairs. The long, rather linear leaves are opposite at the swollen joints of the stem, and are without leaf-stalks. The purple petals are exceeded by the long-tipped hairy calyx. The seeds are dark and warty (Fig. 9A).

Cow cockle is smooth, with the opposite, unstalked leaves at the swollen joints of the stem. The plants have a whitish colour produced by a whitish material which covers them. The flowers are pinkish, and the seed-pods are broadly winged. The seeds are black, rounded, and warty (Fig. 9B).

Bouncing-bet is a deep green colour, with the base of the leaves attached directly to the swollen joints of the stem. The flowers are tubular with light pink or almost red petals. The seed-pods are elongated, and the seeds gray, flattened, kidney-shaped, and warty (Fig. 9C).

Symptoms: The symptoms in horses and cattle include restlessness, grinding of the teeth, salivation, colic, diarrhoea, rapid breathing, and weak pulse. The animal may die in a coma within twenty-four hours. When small quantities are eaten repeatedly, symptoms may be less intense but more prolonged.

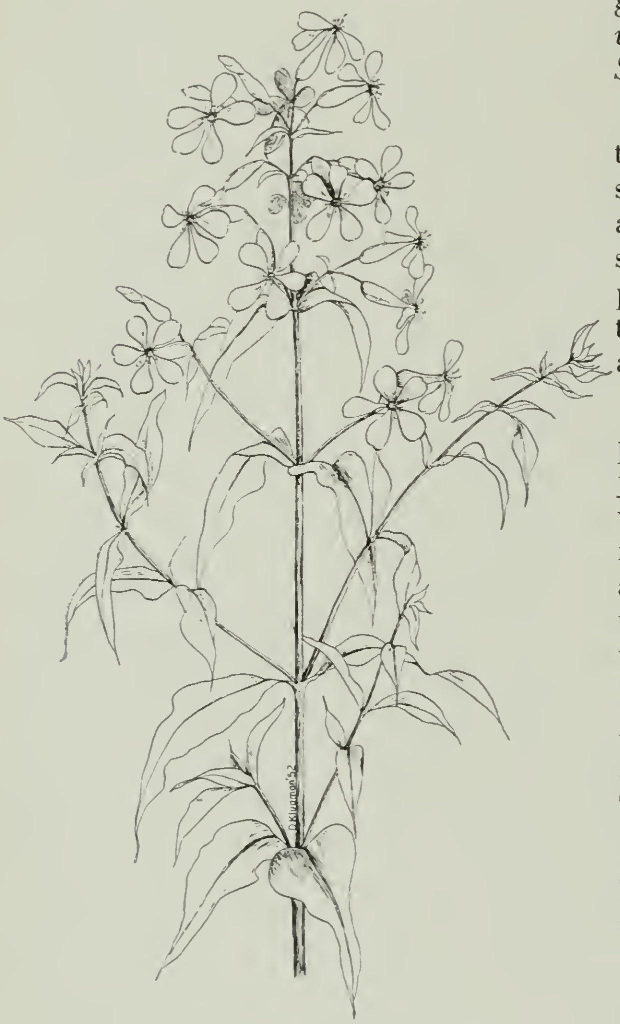


Fig. 8. Bouncing-bet.

Young pigs, which are very susceptible, vomit, develop colic and diarrhoea, and show intermittent rigidity and relaxation of the muscles.

Treatment: When symptoms are first noted, a veterinarian should be called. Laxatives and heart stimulants have proved effective in some instances.

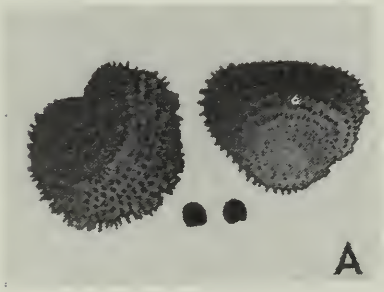


Fig. 9A.
Purple cockle seed.

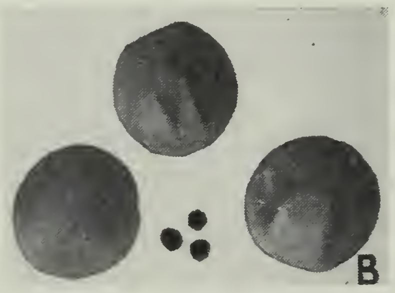


Fig. 9B.
Cow cockle seed.

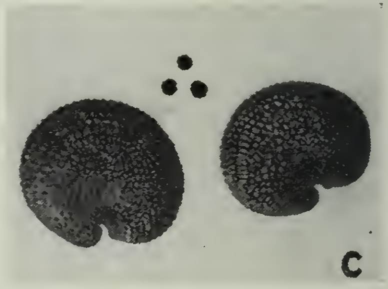


Fig. 9C.
Bouncing-bet seed.

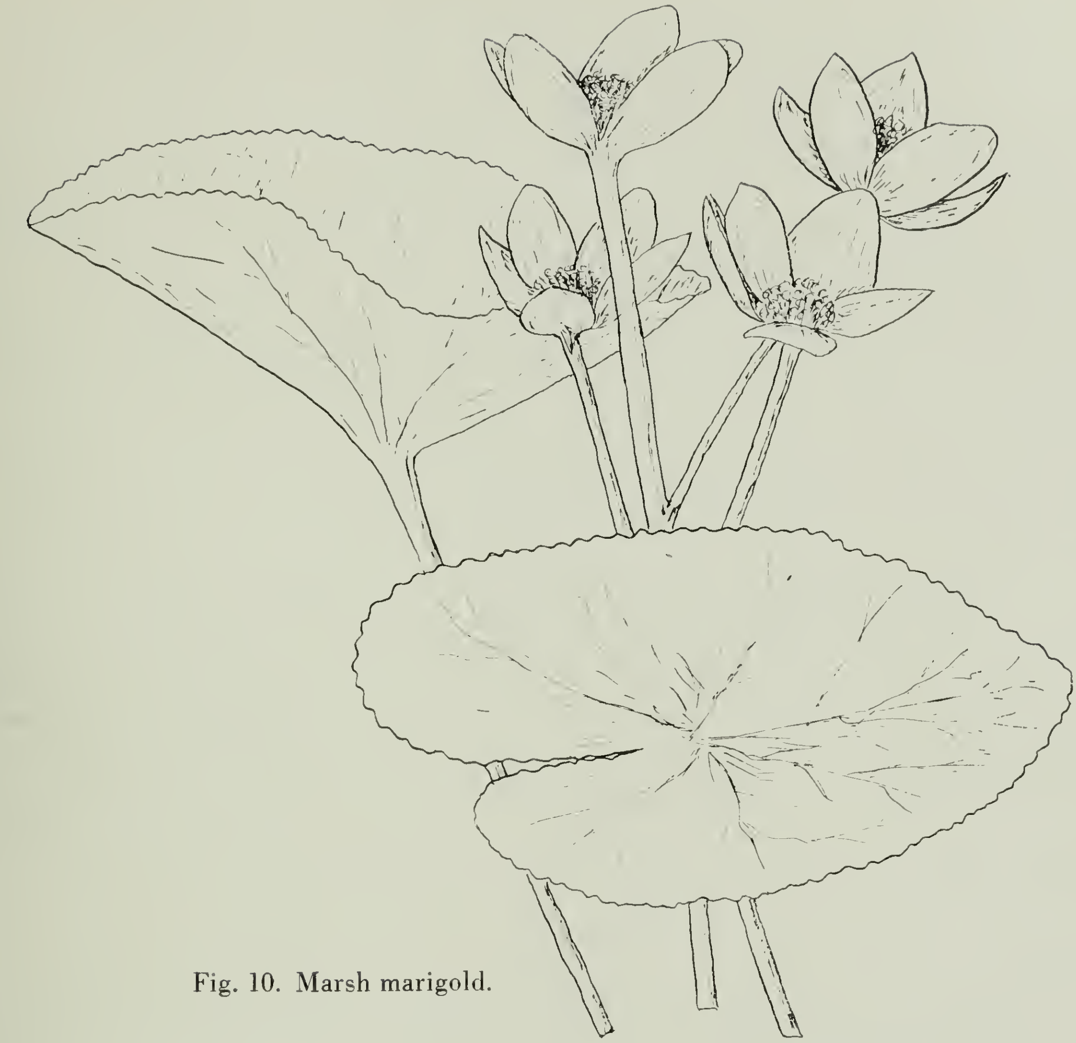


Fig. 10. Marsh marigold.

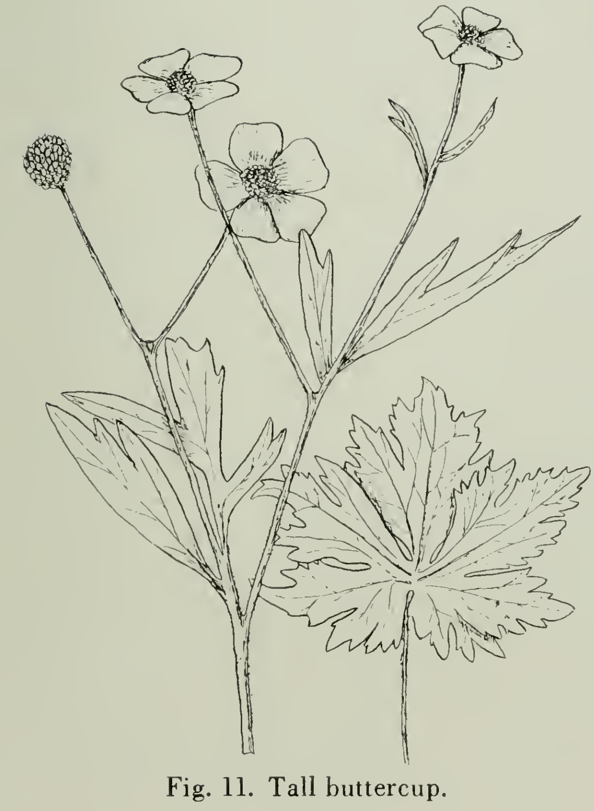


Fig. 11. Tall buttercup.

THE BUTTERCUPS

In the spring the bright-green patches of the leaves and the shiny-yellow, buttercup-like flowers of marsh marigold, *Caltha palustris L.*, are conspicuous before other vegetation has made much progress. The leaves are round, with a deep notch and a large number of blunt teeth (Fig. 10). There are no stems, and the flowers originate from the underground structures. The flowers have 5 to 10 so-called petals and are 1 to 1½ inches in diameter.

Cattle turned loose into low or swampy areas in the spring of the year may feed upon the marsh marigold, and have been known to be poisoned by it. However, it has an acrid taste and is not eaten except in error or of necessity.

Symptoms: Marsh marigolds cause acute inflammation of the stomach and intestines, which is evidenced by vomiting, colic, bloody urine, and foul-smelling diarrhoea. Jerking movements of the eyelids and lips may be observed. The pulse is weak and the breathing loud, and in serious cases convulsions may develop. Small amounts will cause dairy cows to drop in milk yield, and the milk produced may be reddish coloured and bitter.

Treatment: Oily purgatives and heart stimulants are thought to be of value.

Other members of the buttercup family which may cause poisoning are the tall buttercup, *Ranunculus acris* L. (Fig. 11), the small flowered buttercup, *R. abortivus* L., and the cursed crowfoot, *R. scleratus* L. These, like the marsh marigold, are not palatable and are normally left alone.

The poisonous principle of the buttercups is volatile; that is, it is driven off by drying. Therefore, hay containing these plants may be fed with safety. All farm animals are susceptible, but more particularly cattle. If the juice of the plants gets in contact with the skin, inflammation and often painful blisters are produced.

In buttercup poisoning, blisters in the mouth which cause drooling of saliva and loss of appetite, are common symptoms. Other conditions are similar to those of marsh marigold, and a similar treatment should be followed.

DUTCHMAN'S BREECHES AND SQUIRREL CORN

Two early spring flowers, the Dutchman's breeches, *Dicentra cucullaria* (L.) bernh. (Fig. 12A) and squirrel corn, *D. canadensis* (Goldie) Walp. (Fig. 12B), which grow in rich open woods have been known to be poisonous to stock. They are not palatable and are not touched except when animals cannot find sufficient other foods. Without the flowers it is almost impossible to distinguish between these two species by the leaves alone (Fig. 12C). However, squirrel corn has a single, solid, yellowish-brown underground structure, whereas Dutchman's breeches has a clustered rootstalk. Squirrel corn flowers resemble those of the common garden bleeding-heart, but are smaller and only slightly tinged with pink; those of Dutchman's breeches have the two elongated sacs at the base of the flowers, and are slightly yellowish in colour with a deeper yellow at the base of the sacs.

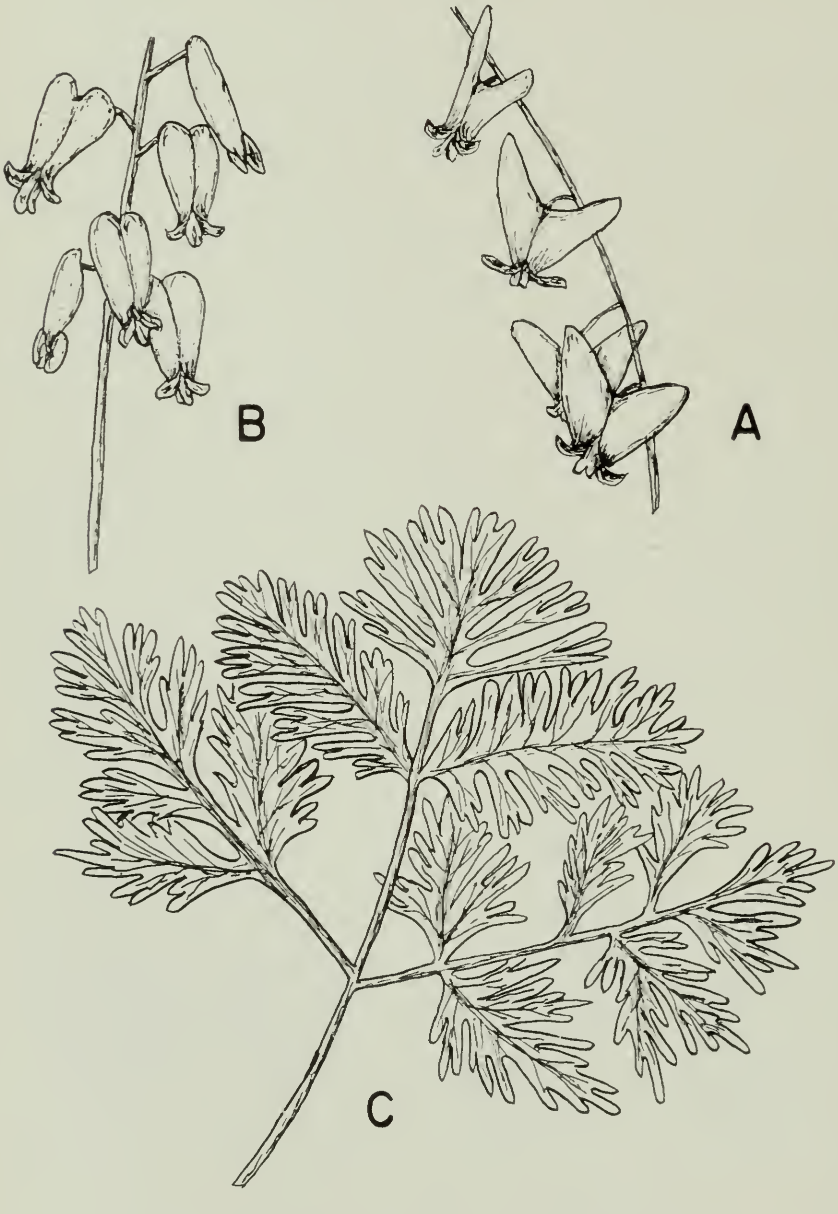


Fig. 12. Dutchman's breeches and squirrel corn.

Both the leaves and underground structures are poisonous, containing the substance *cucullarin.* Cattle are most susceptible, but other animals are known to have been poisoned by the plants.

Symptoms: Symptoms develop about two days after ingestion of the plants, and are indicated by sudden trembling, frothing at the mouth, vomiting, diarrhoea, and laboured breathing. The animal goes down, moans, the eyes become glassy, and the animal may go into convulsions.

Treatment: Laxatives and purgatives may be given to facilitate evacuation of the intestinal tract. In severely poisoned cases, when the animal is too weak to be subjected to severe purging, oils are safer than saline cathartics. Whenever possible, professional assistance should be obtained.

THE MUSTARDS

Although members of the mustard family are not generally considered poisonous, it is recognized that the seeds of several species are troublesome when present in large quantities in feed grains or ground foods.* The seeds contain substances which eventually form mustard oils, and these toxic materials are formed under certain conditions. As mustard oil requires the presence of an enzyme for its formation and liberation from the glucoside, feeds containing ground mustard seeds should not be wetted or soaked before feeding.

Symptoms: Mustard oils are very strong irritants. Typical symptoms are haemorrhagic diarrhoea, colic, abortion, excretion of bloody urine, and paralysis of the heart and respiration.

Treatment: Professional advice should be obtained.

RAPE

Rape is a valuable forage crop in the late fall when other pastures are becoming dried and ripened. It is of particular value where beef cattle are being grazed, and it is also used for sheep and hogs. Most cases of rape poisoning have been recorded in the seasons in which there has been an abnormal amount of moisture and early frosts. It has been reported that, in such seasons, the rape plant develops a purple colour in its leaves and that, in this state, it is considered dangerous. Rape grown on phosphorous-deficient soil, or in poorly drained, low lying areas, is considered to be more toxic.

Symptoms: There are great variations in the symptoms shown by animals poisoned by rape. The respiratory system is generally affected, giving rise to rapid and labored breathing. In severe cases air may be felt under the skin of the back or in other locations. The temperature usually rises. The paunch may be full and partially paralyzed, with the animal passing little or no manure. Blood may be seen in the urine, with or without other symptoms. Nervous symptoms such as incoordination of movement and blindness are seen occasionally.

Treatment: Professional assistance should be obtained as rapidly as possible. Nourishing foods such as second growth alfalfa, bran, molasses or mangolds should be fed during convalescence.

Prevention: Allow cattle to fill up on hay before being turned into rape pasture. Allow animals to have access to hay or straw at all times. Cattle on rape pasture should be watched so that cases of poisoning may be detected early. If the rape crop shows a purple discoloration it should be pastured with great caution. For the first few days restrict the time animals are allowed on the rape pasture and gradually increase this time. unless poisoning symptoms are visible. Avoid growing rape on phosphorous deficient soil.

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*Experiments at Montana State College (1946) indicate that up to 10% mustard seed may be included in the concentrate fed to milking cows without injury to the animals or to the milk and milk products.

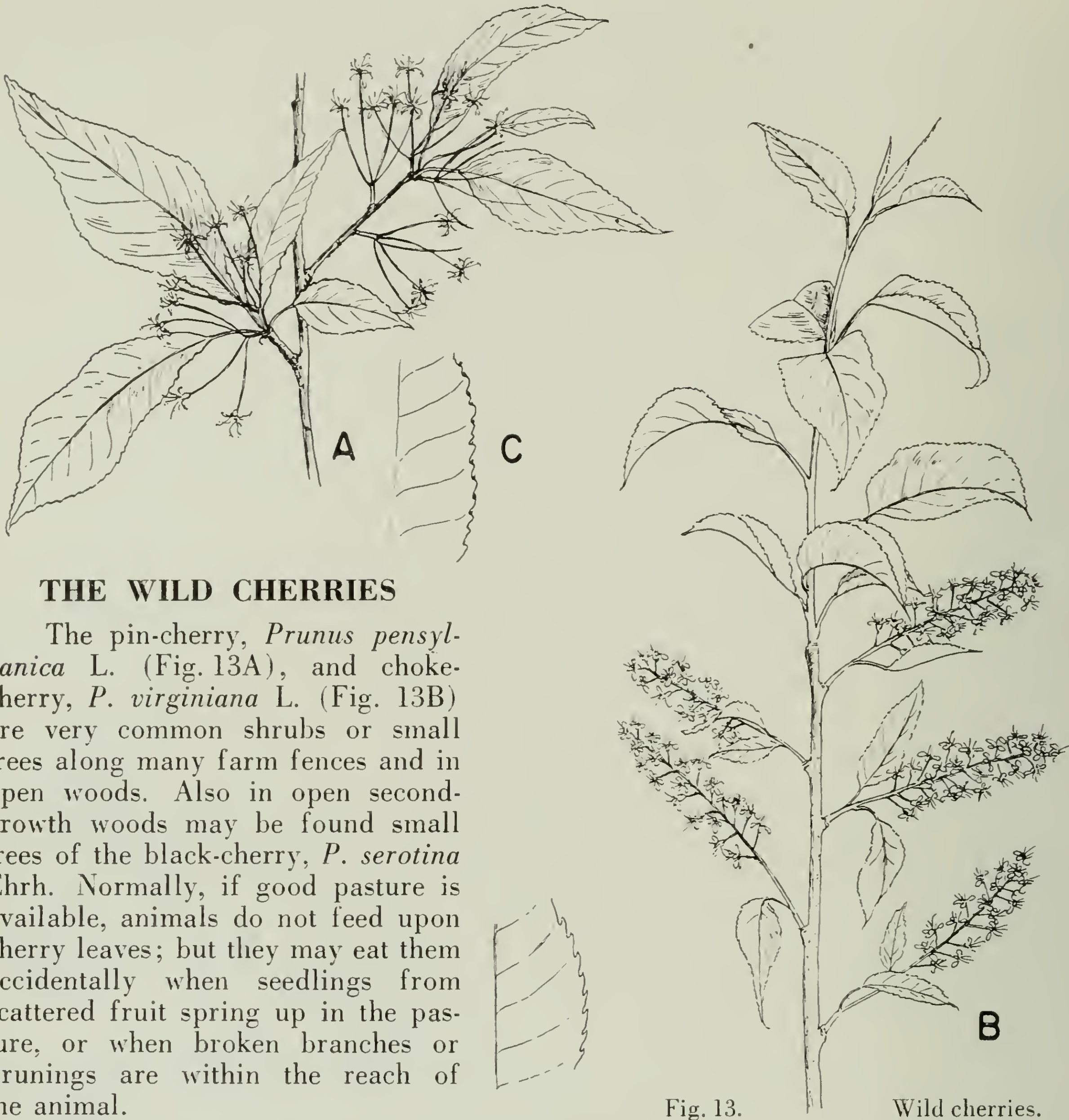

Fig. 13. Wild cherries.

THE WILD CHERRIES

The pin-cherry, *Prunus pensylvanica* L. (Fig. 13A), and choke-cherry, *P. virginiana* L. (Fig. 13B) are very common shrubs or small trees along many farm fences and in open woods. Also in open second-growth woods may be found small trees of the black-cherry, *P. serotina* Ehrh. Normally, if good pasture is available, animals do not feed upon cherry leaves; but they may eat them accidentally when seedlings from scattered fruit spring up in the pasture, or when broken branches or prunings are within the reach of the animal.

The pin-cherry is distinguished by its clustered flowers or fruits, and elliptical, taper-pointed leaves. The choke-cherry and the black-cherry have the many flowers and fruits distributed along a common flowering-stalk. The leaves are oval, and in the choke-cherry the margins have numerous sharp-pointed teeth. The margins of the leaves of black-cherry have blunt teeth which are brown tipped (Fig. 13C).

There appears to be some doubt as to the conditions under which cherry leaves are poisonous. It is said by many, however, that cherry leaves when damaged or in a wilted condition may cause hydrocyanic acid poisoning.

Symptoms and Treatment: See marsh arrow-grass p. 10.

LEGUMES

Few of our native legumes are reported to be poisonous. The common cultivated crops included under the general name of clovers are the chief sources of trouble in this family.

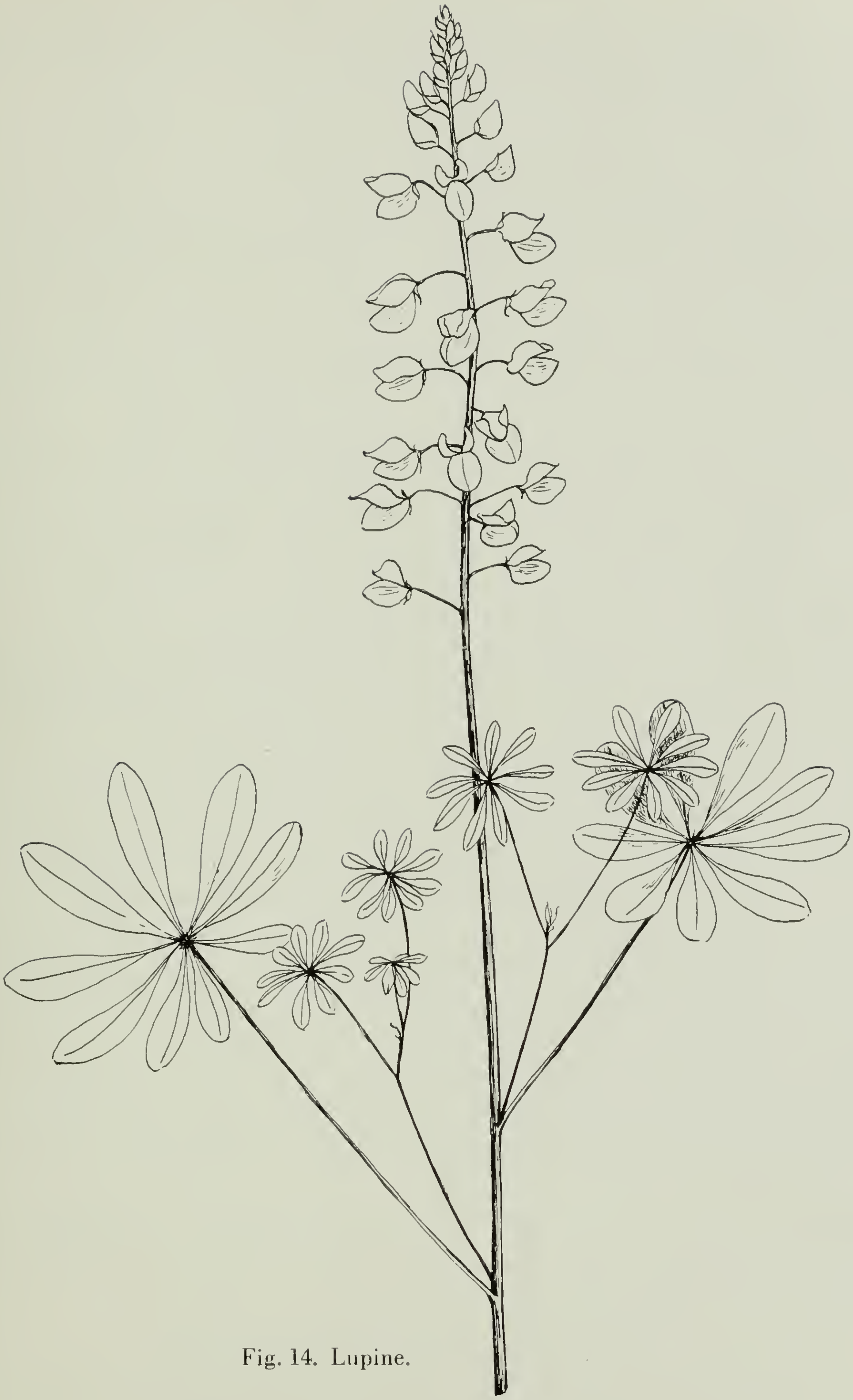

Fig. 14. Lupine.

LUPINE, *Lupinus perennis* L. (Fig. 14)

This lupine is found in some areas around the Great Lakes. It has not been proven to be poisonous in Ontario, but it is known to cause serious losses in Western Canada.

Poisoning by lupines is sometimes known as *Lupinosis.* Sheep are most commonly affected, but there are reports of losses in both cattle and horses. The seedpods are considered to be the most dangerous part of the plant.

Symptoms: Affected animals show nervousness, labored breathing, and convulsions, and frequently, frothing of the mouth, frenzy, and aimless running about. The death rate from this poisoning is very high.

Treatment: No medicinal therapy is known. The advice of a veterinarian should be obtained.

SWEET CLOVERS, *Melilotus* spp.

The sweet clovers are normally good livestock food, but poorly cured or spoiled sweet clover is often poisonous to animals. Sweet clovers contain a substance called *coumarin* which impairs the clotting ability of the blood, and haemorrhages may occur in animals. Sweet clover hay showing any evidence of spoilage should be regarded with suspicion, and great care exercised in its use. Cattle are considered to be most susceptible to this form of poisoning, although other animals have been affected.

Symptoms develop after animals have fed for ten days or more on affected hay. Internal or external haemorrhage is the most prominent feature of the condition. Internal haemorrhage may be indicated by stiffness, weakness, short shallow breathing, and swellings under the skin. External haemorrhage may be the result of accidental wounds, surgical operations, or parturition. Death through loss of blood is the usual result unless treatment is applied promptly.

Treatment: The feed should be changed and the animal placed in a well-bedded stall where the danger of injury is minimized. Blood transfusions from a healthy animal constitute the most effective treatment. Surgical operations should not be conducted while animals have sweet clover included in their diet.

Prevention: Sweet clover hay should be cut early, preferably when the crop is in bud. Salt added at the time of storing or stacking is beneficial. It is very important that the hay be protected from moisture during storage. If the hay shows evidence of spoilage, it should be fed sparingly and only to mature stock.

RED AND ALSIKE CLOVERS, *Trifolium* spp.

Red clover and alsike clover cause photosensitization when eaten in quantity by animals (See St. John's-wort p. 21). Alsike clover also causes a more serious form of poisoning in horses. Affected horses show nervous symptoms such as depression alternating with excitement, yawning, grinding of the teeth, and contraction of the neck muscles. Pastured horses may walk continually around the edge of a field or in a small circle. In some instances loss of appetite, emaciation, and jaundice are the principal symptoms. Recovery may take place, but more often the disease progresses to paralysis and death. A feature of the post-mortem findings is a greatly enlarged liver.

Treatment: There is no specific treatment. Removal from alsike pasture in the early stages, administration of a laxative, and feeding on grain and grass hay are sometimes followed by recovery.

MOLYBDENUM POISONING

The Report of the Committee on Livestock Mineral Problems, 1954, states that, in certain parts of Dundas and Carleton counties in eastern Ontario, there are abnormal quantities of molybdenum in the soil. Cattle pasturing in these areas are often subject to acute scouring. The animals at the same time become emaciated, produce less milk, and their coats become rough and often faded. These symptoms have been traced to the molybdenum content of the legumes, particularly red and alsike clovers, growing in the pastures.

To counteract the effect of molybdenum, it is necessary to add copper to the diet of animals. A veterinarian should be consulted where this type of poisoning is suspected.

ALFALFA, *Medicago* spp.

Alfalfa or lucerne may also cause trouble under certain conditions. Overfeeding by animals on fresh plants may cause bloating due to gases formed in the stomach. There is less danger when animals are pastured on a mixture of alfalfa and grasses than on a pure stand of alfalfa.

Bloated animals should be removed from the pasture, a gag placed in the mouth to facilitate the expulsion of gas, and professional assistance summoned. A home remedy sometimes used in emergency consists of an ounce of turpentine in a pint of milk given as a drench.

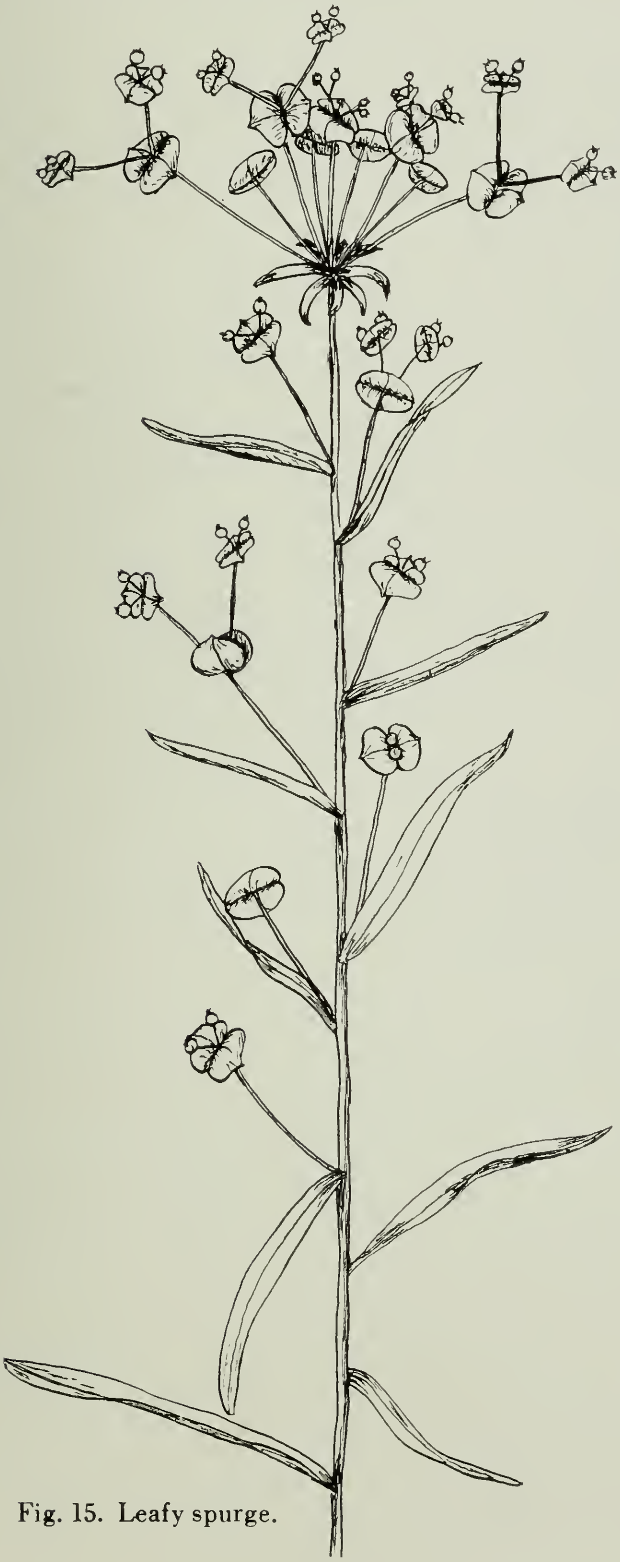

Fig. 15. Leafy spurge.

FLAX

Common flax, *Linum usitatissimum* L., contains a hydrocyanic acid forming substance, particularly in unripe seeds, and in damaged, frosted, or immature plants. Linseed cake or linseed meal may be dangerous if fed following a period of soaking the material in water. Boiled linseed has not been known to cause poisoning.

Symptoms and Treatment: See marsh arrow-grass p. 10.

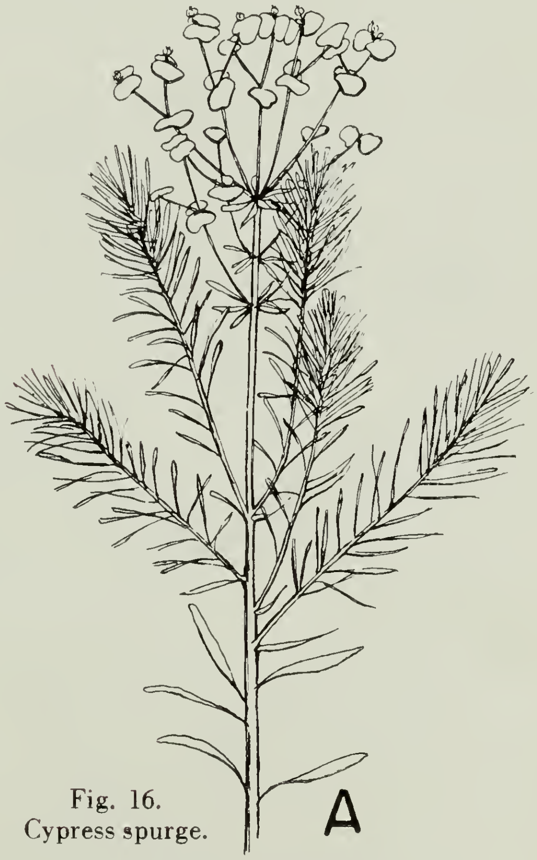

Fig. 16. Cypress spurge.

THE SPURGES

Several of the spurges may cause poisoning. Leafy spurge *Euphorbia esula* L. and Cypress spurge, *E. cyparissias* L. are two common weedy species growing in Ontario which are toxic to some stock animals when eaten in quantity. Sheep can apparently feed upon these spurges with no ill effects. The spurges are not palatable and are only eaten when other pasture plants are scarce.

Both species of spurge are perennial, with milky juice, and reproduce by seeds and underground stems. They have alternate linear leaves and inconspicuous flowers subtended by rather large greenish-yellow bracts. Leafy spurge (Fig. 15) is tall and erect, whereas Cypress spurge is low and bushy in appearance (Fig. 16).

The toxic agent contained in the sap of the plant is *euphorbon*.

Symptoms: Contact with the milky sap may cause inflammation and blistering of the skin, particularly on the lower parts of the legs of work horses used in cutting spurge infested crops. The udders of cows pasturing in infested fields may show similar symptoms.

When eaten, spurges are irritants, and may cause diarrhoea and vomiting. Swelling around the mouth and eyes develops. There are abdominal pains, muscular tremors, irritation in the mouth and throat, and abundant sweating. Animals feeding for some time on infested hay weaken, scour, collapse, and may finally die.

Dairy cows may give bitter-tasting or reddish-coloured milk; milk from affected goats has caused diarrhoea in humans.

Treatment: Professional advice should be obtained. Treatment includes the administration of intestinal astringents, gastric sedatives, and heart stimulants.

ST. JOHN'S-WORT, *Hypericum perforatum* L.

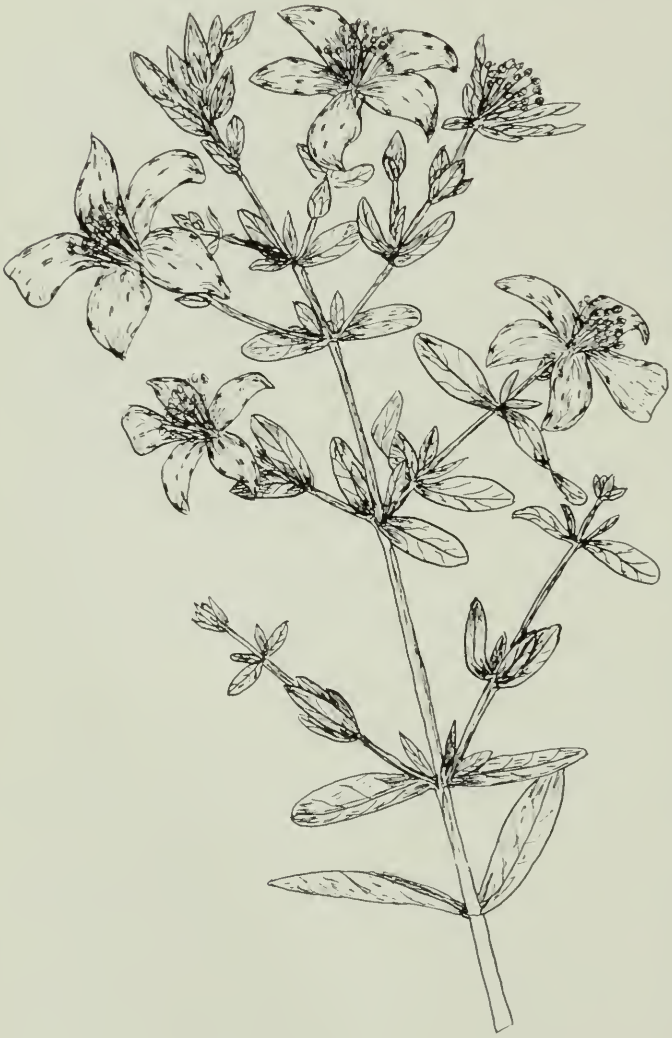

Fig. 17. St. John's wort.

St. John's-wort (Fig 17) is a common weed along roadsides, in pastures, and in open woods. Its presence often indicates poor or worn-out soil conditions. It has a perennial underground stem from which new plants may be produced each year. The stems are smooth, branching and rather bushy in appearance. The leaves are opposite, and if one holds a leaf toward the light, it appears to have numerous holes or white dots. The flowers are bright-yellow with black dots on the petals.

St. John's-wort is one of a number of plants, the consumption of which may result in the serious skin trouble called photosensitization. This condition is caused by the absorption into the blood of certain substances in the plant, and their subsequent reaction to direct sunlight.

Symptoms: Consumption of the plant in the flowering stage, and exposure to intense sunlight may be followed by an inflammation of the unpigmented portions of the skin. This effect may be noticed in horses, cattle, pigs, and sheep. The affected areas become swollen, sore, and reddened, and the skin may peel. In some cases the tongue and mouth are affected, and the animal refuses to eat. Increased temperature and diarrhoea are frequent symptoms. Death may occur in a small proportion of cases.

Treatment: Affected animals should be protected from direct sunlight, and the inflamed skin treated with antiseptic ointments or lotions.

If possible, white-skinned animals should not be allowed access to the weed. If consumption cannot be prevented, adequate shade should be provided.

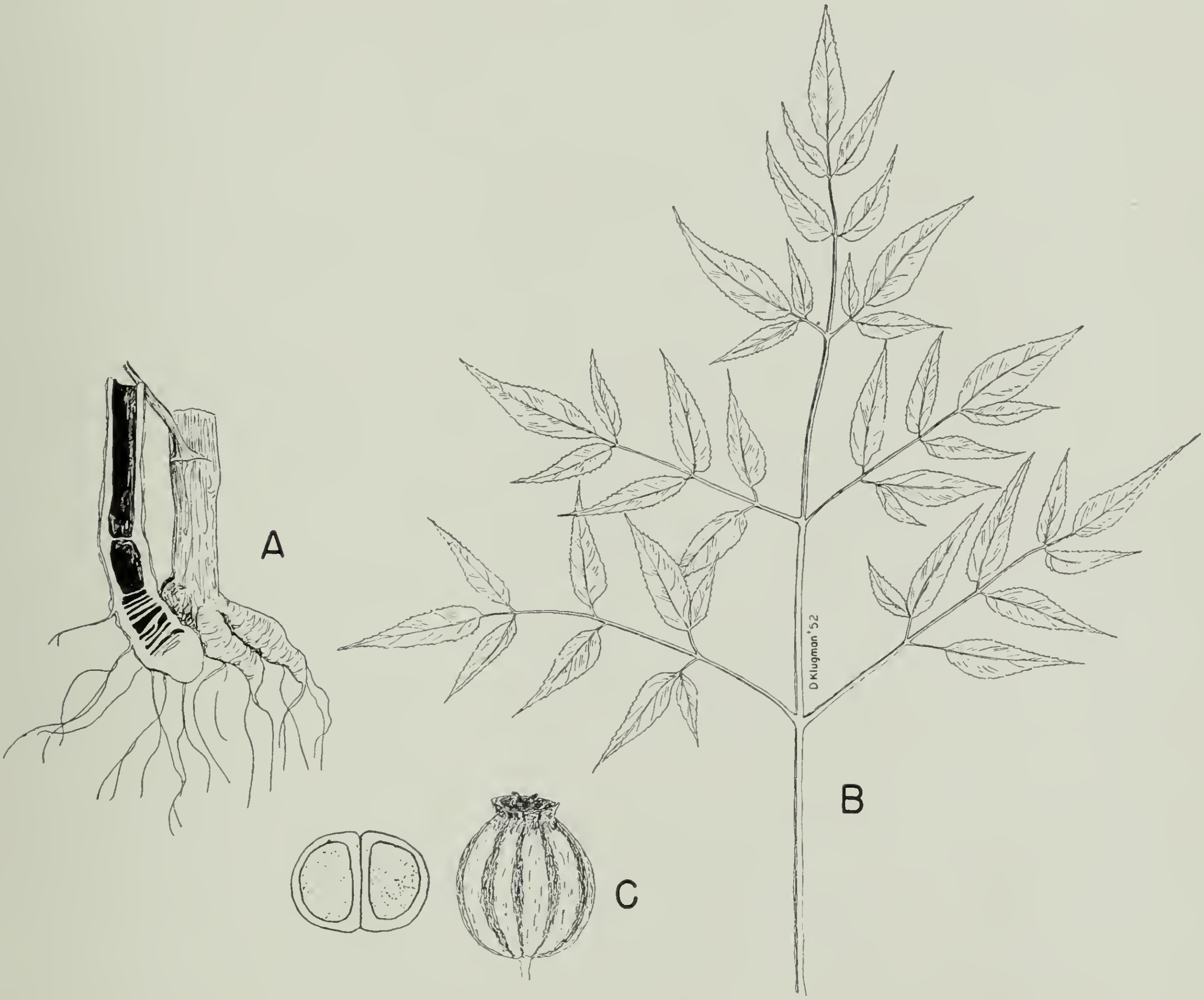

Fig. 18. Water hemlock. A, Base of stem and root. B, Leaf. C, Fruit.

WATER HEMLOCK, *Cicuta maculata* L.

Water hemlock (Fig. 18) is found in wet pastures, along stream banks and margins of ponds and lakes. Pastures in such areas should be examined carefully for this plant before animals are turned into them. This examination is particularly necessary if grasses are scarce, or the animals are hungry. The most likely times for stock to eat the plant are in the spring and fall when forage is scarce. The most dangerous portion of the plant is the root, and it has been proven experimentally that a very small portion of the root is sufficient to kill a cow. The stems and leaves, especially in the early growth stages, are also considered to be a menace to livestock; old tops are not thought to be dangerous. The seeds are considered to be only slightly toxic. In domestic animals most losses occur among cattle, although fatalities of horses, sheep, and swine have been reported.

The plant is a perennial, reproducing by seeds and the somewhat dahlia-like

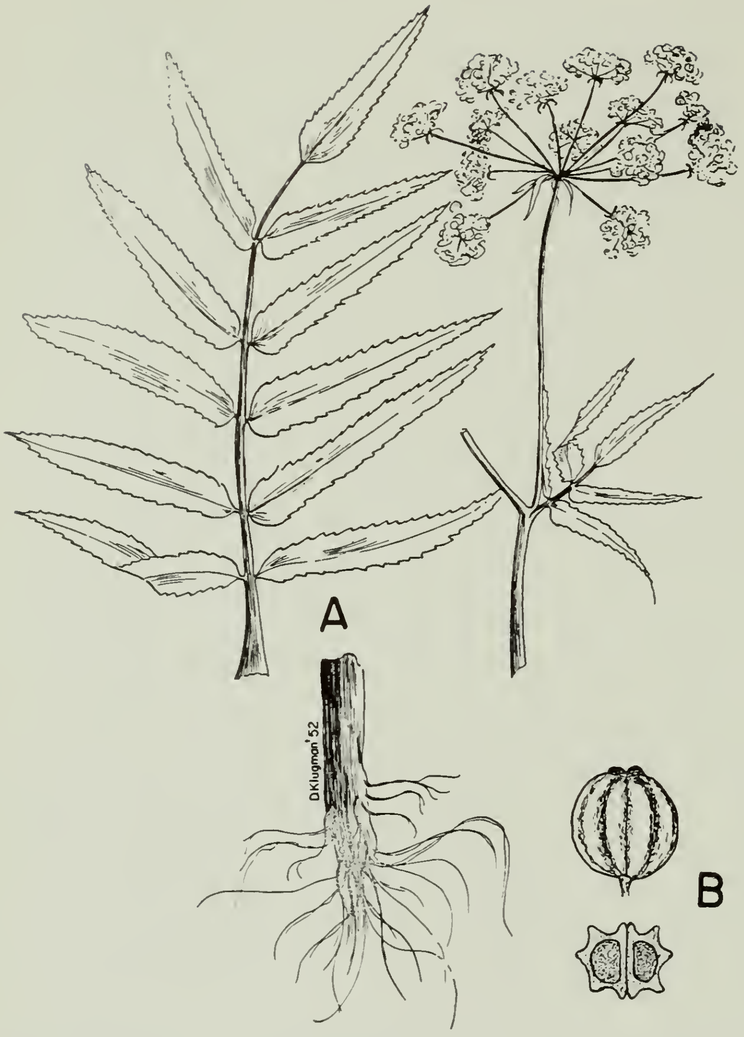

Fig. 19. A, Leaf root and flowers of water parsnips. B. Fruit.

root structures shown in Fig. 18A. The cross-partitions, Fig. 18A, at the base of the stem of a well developed plant are characteristic. The stems are hollow, often purple-striped or purple-dotted, and ridged. The leaves are three-parted with each division again divided, and the leaflets have sharp-toothed margins (Fig. 18B). The seeds are also quite characteristic, and are useful in the identification of the plant (Fig. 18C).

Symptoms: Death may occur within 15 minutes after a toxic quantity of the plant has been eaten, but more often, two or three hours may elapse. In less severe cases the animal may live for a day or two. If the animal survives beyond this time, complete recovery may be expected.

Frothing at the mouth, followed by uneasiness and pain, is one of the first evidences of poisoning by water hemlock. There are dilated pupils, groaning, clamping of the jaws, grating of the teeth, turning of the head and neck, rapid kicking, and rigid extension of the legs. The pulse is weak and rapid, and diarrhoea is generally observed. Bloating and spasmodic contractions of the diaphragm are frequent symptoms. Intermittent convulsions increase in frequency and intensity, and are terminated by death due to respiratory failure.

Treatment: As a rule, death occurs so quickly that no effective treatment can be applied.

NOTE: Water hemlock should not be confused with water parsnip *Sium suave* L., which grows in similar habitats. The leaf of water parsnip (Fig. 19A) readily distinguishes it from water hemlock; water parsnip does not have the three-parted leaf. Water parsnip also lacks the dahlia-like roots and the cross-walls in the lower part of the stem. The seed (Fig. 19C) is an identifying feature. This plant has been considered to be poisonous, but doubt exists as to the authenticity of the reported cases.

THE LAURELS

The laurels, *Kalmia* spp. (Fig. 20) are most frequently found in our boggy areas. The plants are dwarfed, shrubby, tough-stemmed, and with opposite, leathery leaves. Because of these characteristics, animals usually do not eat them if other food is available. Most cases of poisoning occur in the winter or early spring when the leaves are the only conspicuous green food available. Cattle, horses, and goats are susceptible, but most cases are reported in sheep.

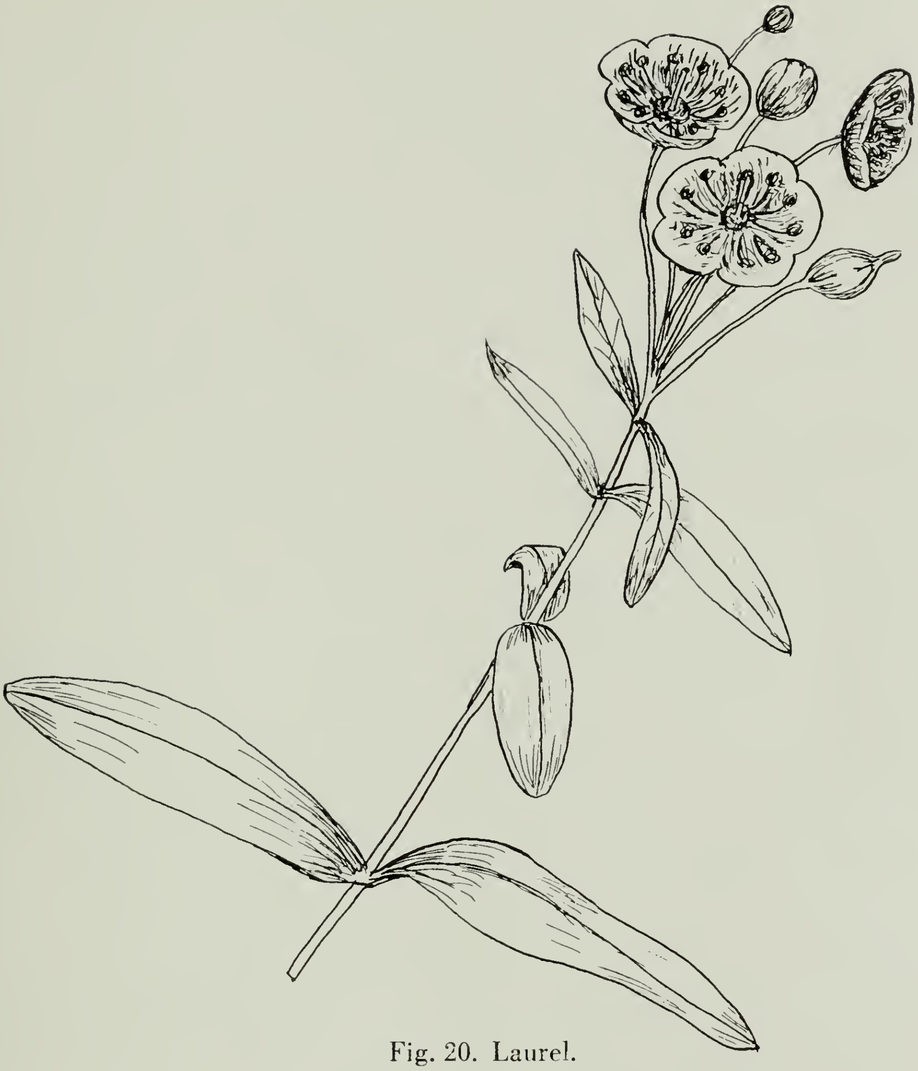

Fig. 20. Laurel.

Symptoms: Salivation, an increased flow of secretions from the nose, and vomiting with convulsions may be present, and are followed by paralysis of the limbs. Irregular respiration is an occasional symptom. Grating of the teeth, complete or partial loss of sight, and extreme drowsiness are also typical symptoms followed by coma and death.

Treatment: No specific remedial agent is known. Epsom salts, given as a drench, may be useful in eliminating the poison. Lard is reported to be useful if given soon after the leaves have been consumed.

DOGBANE

Indian hemp, *Apocynum cannabinum* L. and spreading dogbane, *A. androsaemifolium* L. (Fig. 21) grow in a variety of habitats, but are not found in good pasture land; only animals pastured on unused land are likely to come in contact with them. Very small quantities of either plant are sufficient to cause poisoning and death. Horses, cattle, and sheep are susceptible.

Spreading dogbane is low and spreading, whereas Indian hemp is tall and erect. Both plants are somewhat woody, and have opposite smooth-margined leaves on the stems. The pinkish or greenish flowers are in clusters, and produce slender milkweed-like pods.

Symptoms: Among the first symptoms to be observed are a rise in temperature and an increased pulse. The extremities become cold, and the pupils of the eyes

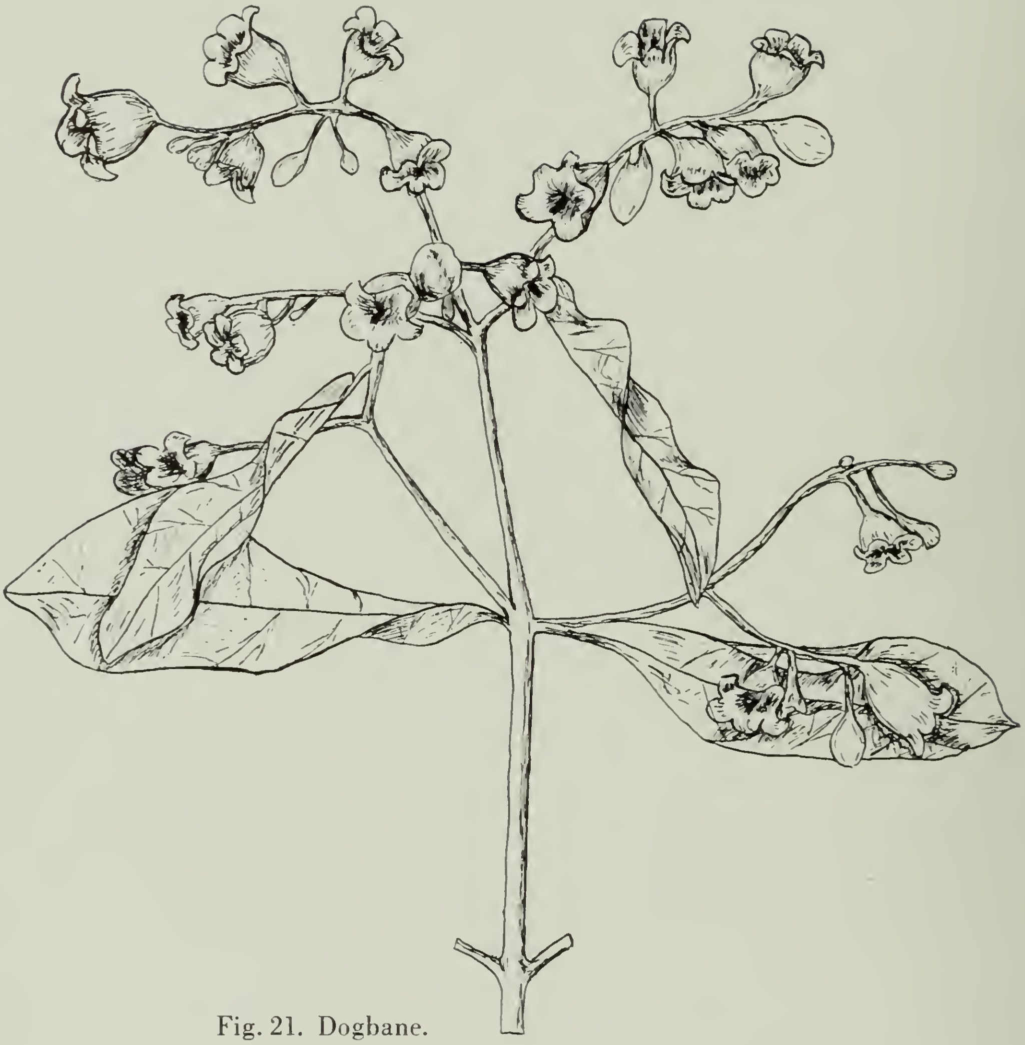

Fig. 21. Dogbane.

dilate. The mouth and nostrils become discoloured, and the mouth becomes sore. The animals refuse to eat and drink, and death follows.

Treatment: Professional advice should be obtained. No specific treatment is available, but purgatives such as Epsom salts or oils may be helpful in the early stages.

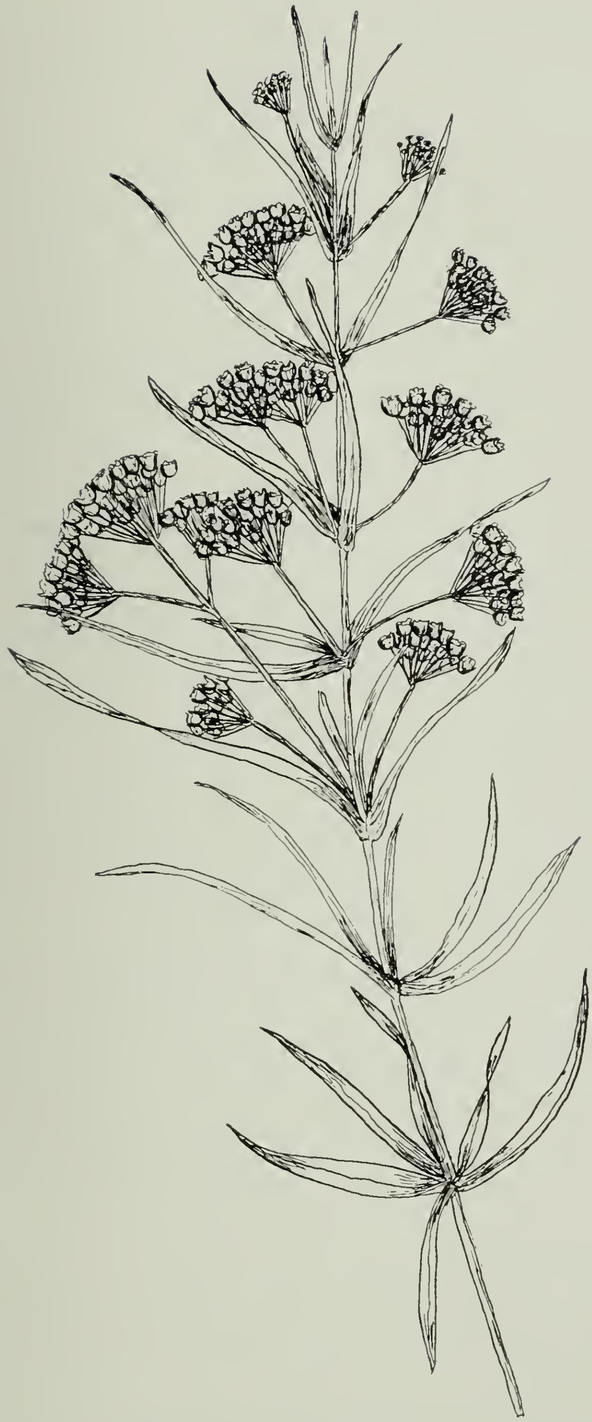

Fig. 22. Whorled milkweed.

WHORLED MILKWEED

Asclepias verticillata L.

Nearly all the milkweeds are toxic to domestic animals, but in southern Ontario the whorled milkweed (Fig. 22) is the one considered the most dangerous. It is most frequently found in sandy areas and open woods in the vicinity of the lower Great Lakes. It has a tall, erect stem with whorls of narrow leaves and inconspicuous greenish flowers. It has a bitter taste which makes it unpalatable, but when food is scarce, animals may eat it.

Cattle and horses are the most susceptible, although sheep are also affected. Serious poisoning may also occur from the feeding of hay containing large quantities of this weed.

Symptoms: Cattle may develop symptoms within a few hours after eating the dry plant. Symptoms include loss of appetite, constipation, bloating, and drooling. The pulse may be rapid and weak, and breathing difficult. In severe cases, there may be excitement and convulsions, and the death rate is high. Horses tend to develop a persistent colic, but usually recover.

Treatment: No specific treatment has been discovered although laxatives are advised.

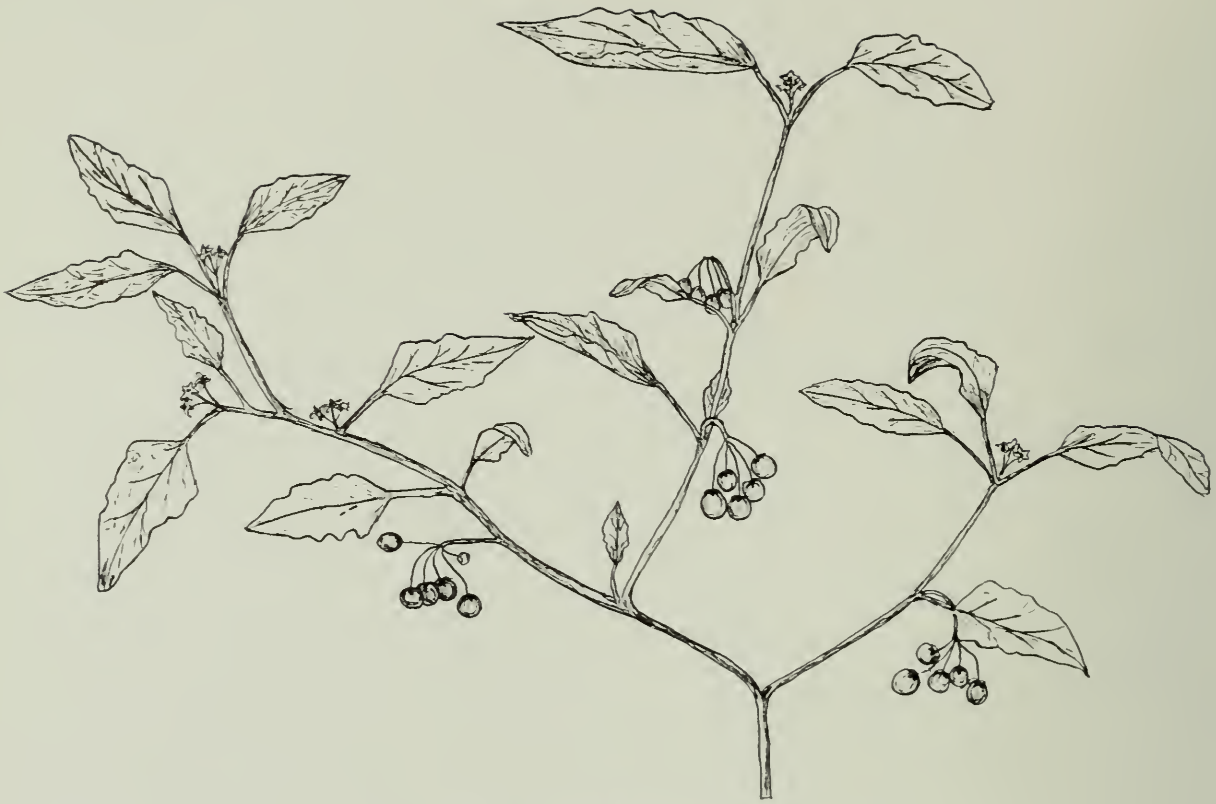

Fig. 23. Black nightshade.

BLACK NIGHTSHADE, *Solanum nigrum* L.

Black nightshade (Fig. 23) has long been placed high on the list of poisonous plants. While in some parts of the world the plants and fruit have been consumed with no ill effects, in other areas humans, cattle, sheep, goats, pigs and poultry have been poisoned. Undoubtedly there are many varieties in the world, some of which are more poisonous than others. Actual poisoning due to the consumption of nightshade is very rare in Ontario, but it is well to treat the whole group of black nightshade with suspicion. The unripe berries are considered to contain the greatest amount of poisonous substances.

The plant is low and branching with alternate, usually wavy-margined leaves. The flowers are in small umbel-like cluster. They are small, white, and resemble in appearance those of the tomato and potato. The fruit is a small, dark, many-seeded berry.

Symptoms: These include stupidity, dilation of the pupils, loss of muscular co-ordination, loss of consciousness, and convulsions. Diarrhoea, loss of appetite, and extreme weakness are also present. Sheep develop a weak, intermittent pulse, accelerated breathing, and staggering gait.

Treatment: The administration of quick-acting purgatives hypodermically appears to be beneficial. Oily laxatives and stimulants may assist recovery. Professional assistance is necessary.

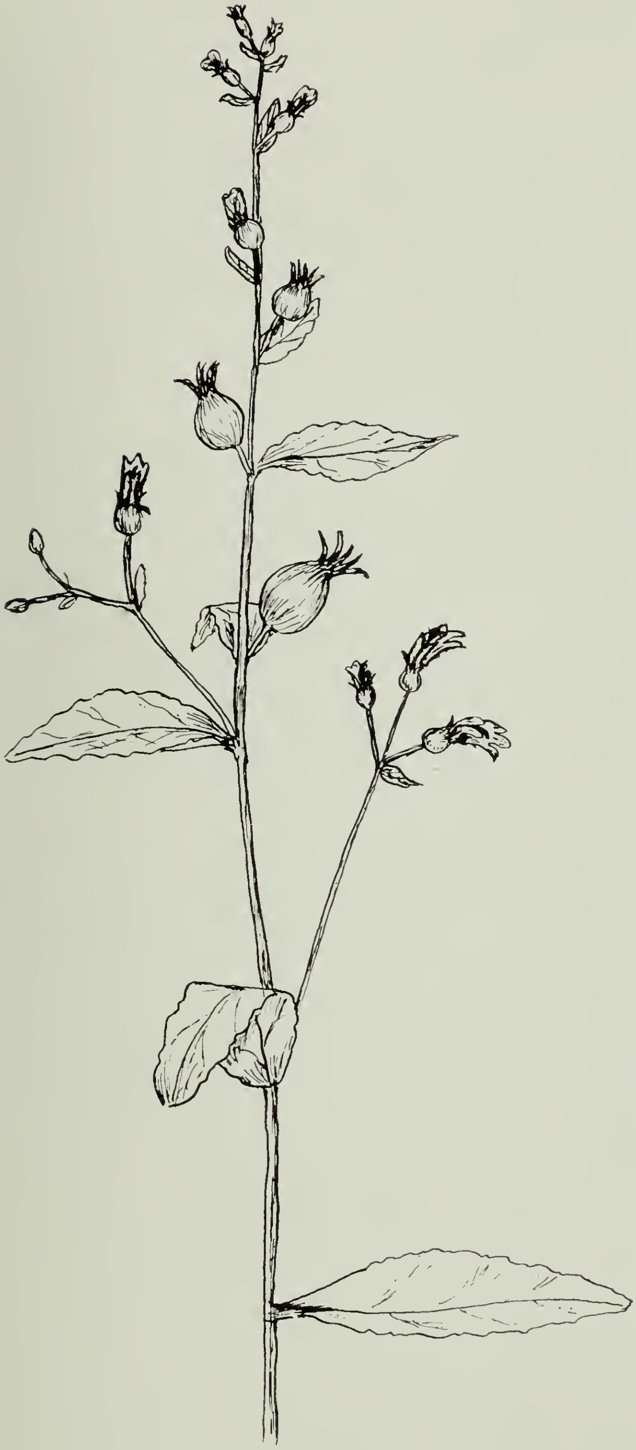

Fig. 24. Indian tobacco.

INDIAN TOBACCO

Lobelia inflata L.

Indian tobacco (Fig. 24) contains poisonous alkaloids which are fatal if the plant is eaten in quantity. In Ontario it occurs most frequently in wooded areas, and this reduces the possibility of fatalities from this plant. Occasionally, however, it does get into pastures, and it is well to be familiar with the plant. The stems are erect and have alternate, toothed leaves. The stems branch, and each branch produces numerous, small, pale blue flowers. These flowers are quite distinctive in that they are split down one side exposing the tube of anthers.

The leaves contain the alkaloid *lobeline* which is a narcotic poison when taken in large quantities. It is probably not a frequent cause of poisoning in Ontario.

Symptoms: The most prominent symptoms are nausea, vomiting, contraction of the eye, exhaustion, mental depression, and stupor. Eventually there is loss of consciousness, and convulsions develop and terminate in death.

Treatment: Professional advice should be procured immediately. Quick acting purgatives and stimulants administered hypodermically may be of some benefit.

WHITE SNAKEROOT

Eupatorium rugosum Houtt.

White snake root (Fig. 25) is found most frequently in rich wooded areas, but persists long after the woods have been thinned out. It varies in height from 1 to 4 feet, has a branching stem and opposite, rounded, pointed leaves. These are long-stalked

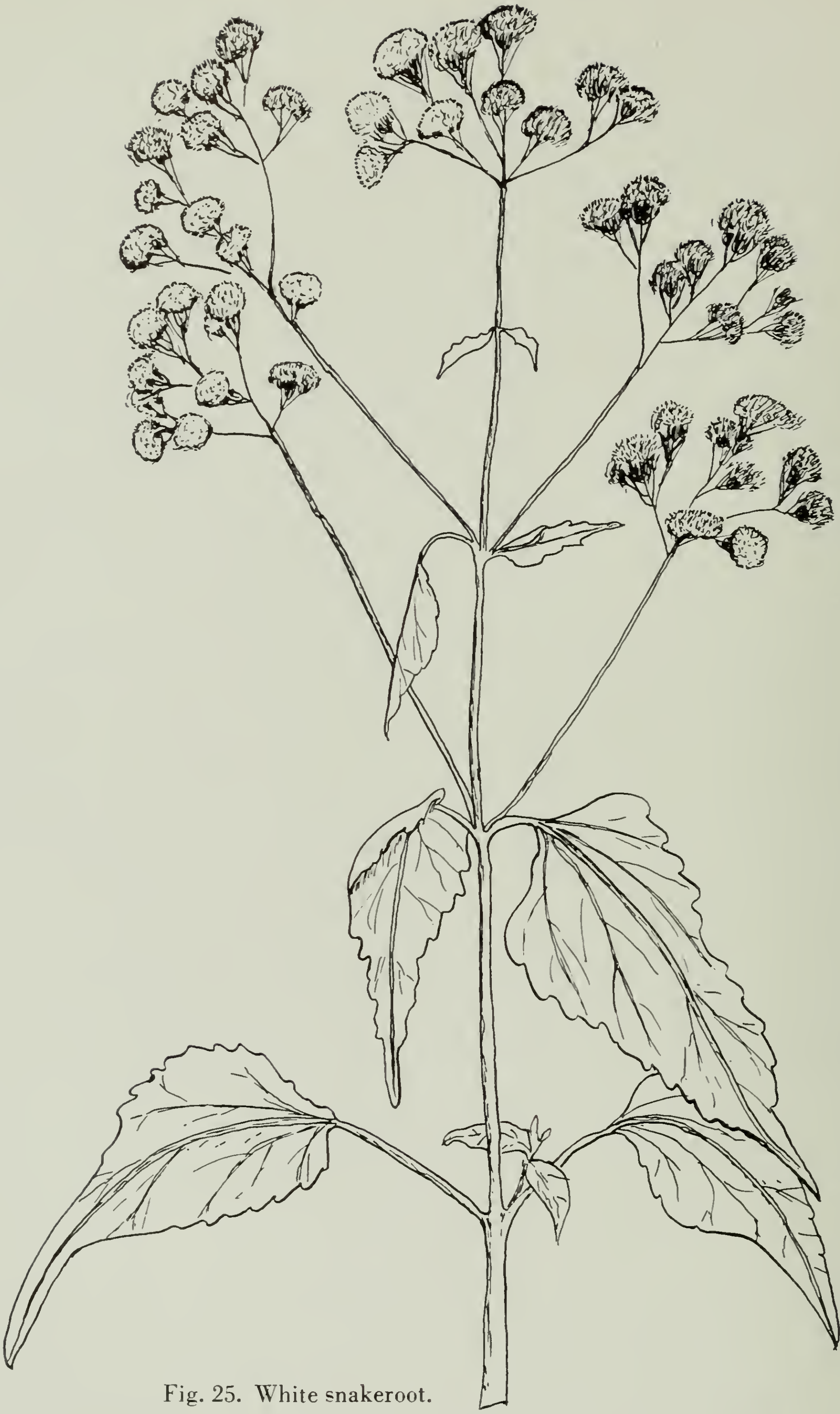

Fig. 25. White snakeroot.

and sharply toothed along the margins. In late summer and autumn the stems and branches are topped by compound clusters of small white flowers.

Animals are likely to feed on this plant when other more desirable food is scarce. The sickness caused by the plant is called *trembles* from the characteristic trembling of the affected animal. The toxic principle, *tremetol,* is one of the higher alcohols and is soluble in fat; it may therefore, be transmitted through milk to young nursing animals and also to humans.

Symptoms: In cattle and horses the symptoms are very similar except that the course of the disease is more rapid in horses. There is a period of depression and inactivity followed by trembling of the muscles, especially around the nose and legs. This trembling usually disappears after a rest. Excessive salivation, profuse nasal discharge, nausea, vomiting, and accelerated and difficult breathing are also present. There is loss of appetite and weight; the animal becomes progressively weak, and is finally unable to stand. If helped to its feet it trembles and stands with the body arched and hind feet placed close together well under the body. Sheep often stand with the legs apart, back bowed, and head lowered. Once down, the animal usually becomes comatose and remains so until it dies.

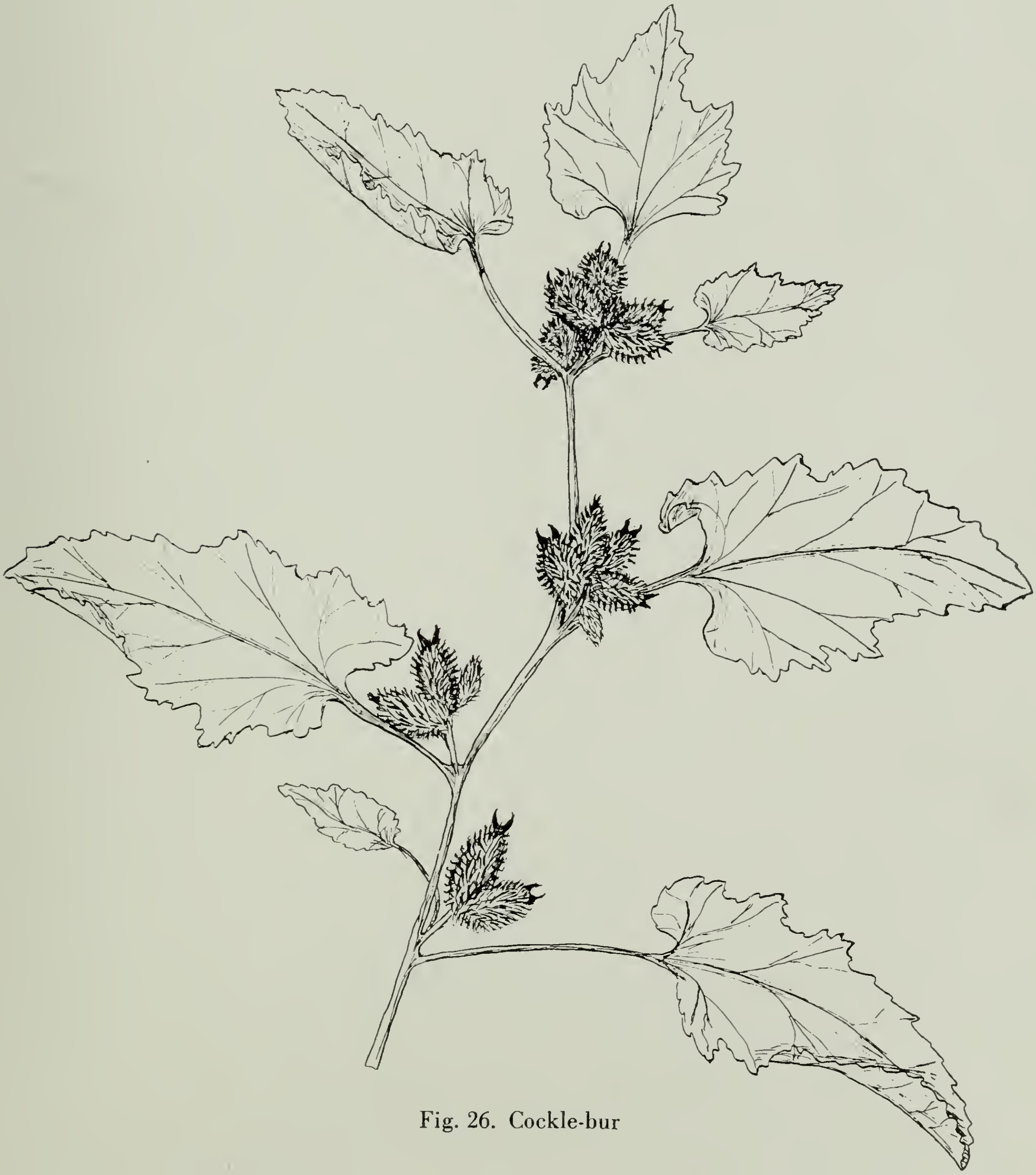

Fig. 26. Cockle-bur

Swine are similarly affected, and stiffness may be observed in the hind legs first. When trembling begins it becomes so severe that the animal falls to its knees or sits on its haunches, finally falling.

Treatment: No satisfactory treatment is known. Oily purgatives, such as castor or linseed oil, are used with repeated doses of stimulants. Careless administration of drugs is dangerous owing to the possibility of throat paralysis.

COCKLE-BUR, *Xanthium* spp.

This plant (Fig. 26) is commonly found along river banks and flats, around the margins of ponds, on low land and even in farm yards. It is also sometimes found in cultivated fields. Although the burs may cause mechanical injury to the digestive tract, it has been found that the seedlings are the more dangerous; however, the danger lessens as the plants mature. The seedlings may be cropped with other foods, often making it difficult to trace the source of the poisoning. Since it is an annual plant, trouble may be looked for in the late spring and early summer.

The toxic principle, the glucoside *xanthostrumarin*, occurs in the germinating seeds and young plants still in the seedling stages. Poisoning occurs in horses, cattle, sheep, swine, and chickens. Each spring many sudden deaths among pigs are traceable to the young pigs eating the seedlings.

Symptoms: These are weakness, unsteady gait, twisting of the neck muscles, depression, nausea, difficult respiration, and rapid, weak pulse. Sometimes vomiting occurs. Symptoms appear a few hours after the eating of the plant, and in fatal cases death usually occurs within 12 to 24 hours after the first symptoms are noted.

Treatment: Administration of fats and oils is of some benefit. The drenching of pigs with whole milk is reported to be particularly successful.

SNEEZEWEED, *Helenium autumnale* L.

This perennial (Fig. 27) is generally distributed in moist places. Its stems are smooth and have alternate leaves whose bases extend some distance down the stem, giving it a winged appearance. The leaf-blades are coarsely toothed in the typical species. The small, sunflower-like heads of flowers have 3-toothed, yellow rays, and the central, small, inconspicuous flowers are greenish-yellow.

All parts of the plant contain an acrid, bitter substance. The toxic properties are concentrated more in the flower-heads; consequently, younger plants are less dangerous. The poisonous content of the plant may vary with the locality. Cattle, sheep, and horses are affected, with cattle and sheep being the most susceptible.

Symptoms: The effects are cumulative, the affected animal gradually showing loss of vigour and flesh. If large quantities are consumed, there is accelerated pulse, laboured breathing, and extreme sensitiveness. The animal loses muscular control, and plunges and staggers blindly. Salivation, vertigo, and high temperature have been reported in some cases. Spasms and convulsions usually precede the death of the animal.

Treatment: There is no specific treatment, although the administration of a purgative would appear to be indicated. The services of a veterinarian may be necessary to diagnose the sickness and to give advice on the method of treatment.

RAGWORT, *Senecio jacobaea* L.

Ragwort (Fig. 28) is found occasionally in Ontario, but is much more common eastward. The plants grow 2 to 3 feet high. The basal leaves are rather large, petioled, and much segmented. The stem-leaves are not petioled and are more or

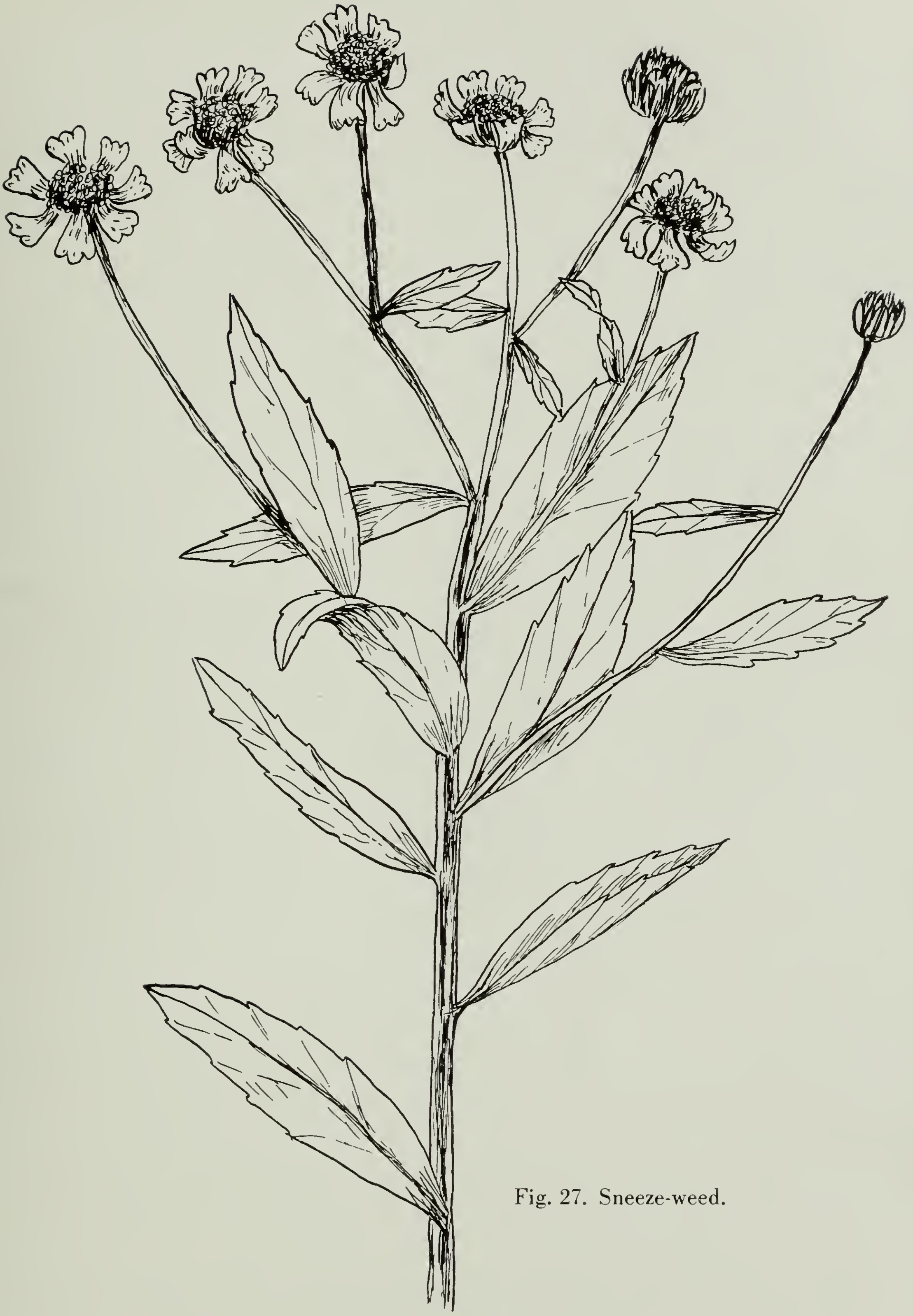

Fig. 27. Sneeze-weed.

less finely dissected. The daisy-like heads occur in dense clusters, and the outer flowers of each head are bright yellow, making the plant very conspicuous.

The poisonous principles contained in the plant is *Jacobine,* and in eastern Canada the disease produced is called *Pictou Cattle Disease.* Cattle and horses are mostly affected, sheep but rarely.

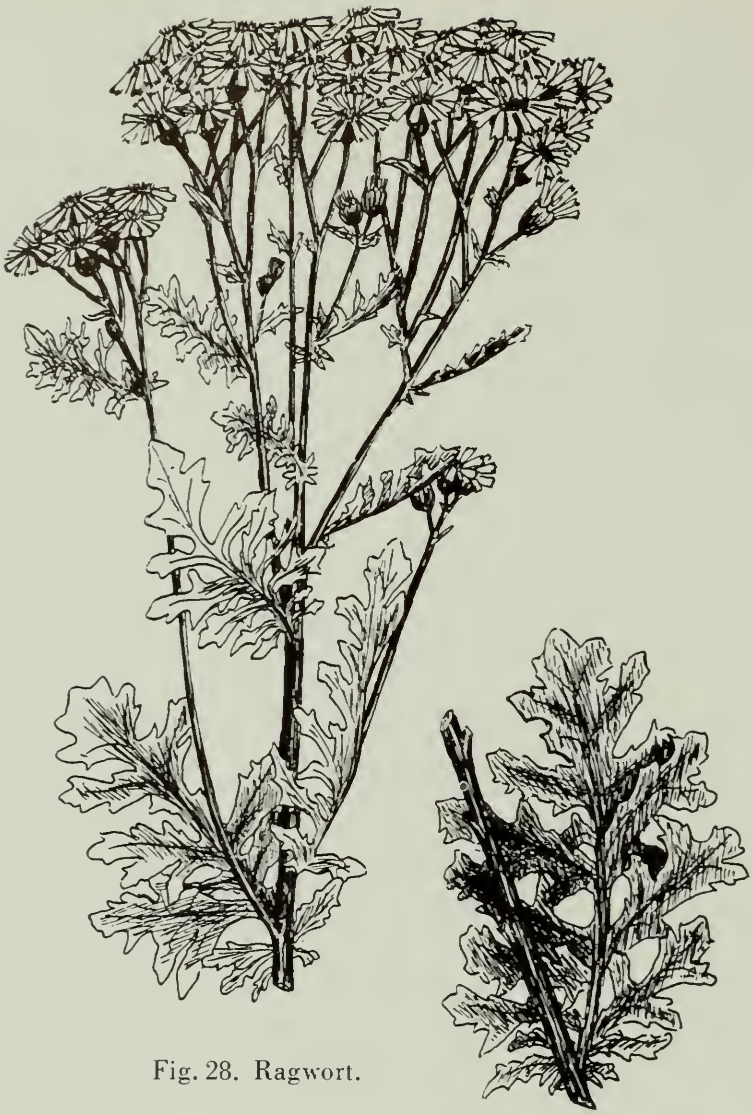

Fig. 28. Ragwort.

Symptoms: At first the animal displays nervous irritability and occasional chills. These are followed by paleness of the mucous membranes. There may be a peculiar blanched appearance to the hair, which seems to have lost its lustre. The pulse is fast and strong, and the temperature may be above normal. The animal becomes emaciated, develops a staggering gait and weakness, and eventually death may occur. A greatly enlarged liver is frequently found on post-mortem.

Treatment: There is no specific treatment, but tonics of iron and strychnine are said to be of value in the early stages of the disease.

PLANTS CAUSING MECHANICAL INJURY

Some plants cause physical or mechanical injury to animals, and this injury may be external or internal. When this occurs, there is also the danger of infection of these injuries, and the infection may prove to be the more serious.

The barbs or awns of wild barley, downy brome grass, and wild rye are often troublesome in the mouths and throats of animals that have fed on the plants. The small backward pointing spines cause the awns to stick in the mouth or throat, and they are difficult to dislodge.

The spiny fruit of the sand-bur, *Cenchrus* spp., is quite stiff, and an animal grazing may injure its muzzle while cropping, or if the burs get into its mouth, they may cause painful injury.

The burs of cockle-bur, *Xanthium* spp., are also a source of annoyance. When the burs are eaten they form an indigestible ball in the stomach. The spines injure the wall of the digestive tract and may thus open the way for secondary infection.

Other plants such as mullein, rabbit-foot clover, and crimson clover are very hairy plants, and these indigestible hairs may form hairy balls which cannot be passed easily from the digestive tract.

PLANTS AFFECTING MILK

Certain plants are known to decrease the milk production of cows that have fed on them; also they may make milk or milk products unpalatable and unsuitable for human consumption. The following list includes a few of the common plants found in Ontario that are known to have these effects:

Horsetails	*Equisetum* spp.
Docks	*Rumex* spp.
Wild onion	*Allium* spp.
Wild garlic	*Allium* spp.
Buttercups	*Ranunculus* spp.
Marsh marigold	*Caltha palustris*
Mustards	A number of species such as false flax, pennycress, common mustard, hedge mustard, turnips, and rape.
Lupines	*Lupinus* spp.
St. John's-wort	*Hypericum* spp.
Spurges	*Euphorbia* spp.
Buckthorn	*Rhamnus* spp.
Wild carrot	*Daucus carota*
Poison hemlock	*Cicuta maculata*
Yarrow	*Achillea millefolium*
Dog fennel	*Anthemis cotula*
Ox-eye-daisy	*Chrysanthemum* spp.
Ragweeds	*Ambrosia* spp.
Chicory	*Cichorium intybus*
Tansy	*Tanacetum vulgare*

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INDEX

Agrostemma githago 16
Alfalfa 23
Algae 7
Apocynum androsaemifolium 27
Apocynum cannabinum 27
Asclepias verticillata 29
Arrow-grass, marsh 13
Barley, wild 36
Black nightshade 30
Bouncing-bet 16
Bracken 10
Buttercups 17
Caltha palustris 17
Cenchrus spp. 36
Cherries, black 20
Cherries, choke 20
Cherries, pin 20
Cicuta maculata 25
Claviceps spp. 9
Clover, alsike 22
Clover, crimson 36
Clover, rabbit's-foot 36
Clover, red 22
Cockle-bur 34
Cockle, purple 16
Cornstalk poisoning 13
Cow cockle 16
Dicentra canadensis 18
Dicentra cucullaria 18
Dogbane 27
Dutchman's breeches 18
Equisetum arvense 11
Ergot 9
Eupatorium rugosum 31
Euphorbia cyparissias 23
Euphorbia esula 23
Flax 23
Helenium autumnale 34
Hemlock, water 25
Hypericum perforatum 24
Indian tobacco 31
Kalmia spp. 26
Laurel 26
Linum usitatissimum 23
Lobelia inflata 31
Lucerne 23
Lupine 21
Lupinus perennis 21
Marigold, marsh 17
Marsh arrow-grass 13
Marsh marigold 17
Melilotus spp. 22
Milkweed, whorled 29
Molybdenum poisoning 22
Mullein 36
Nightshade, black 30
Nitrate poisoning 6
Parsnip, water 26
Photosensitization 22-24
Phytolacca americana 14
Pictou cattle disease 35
Pokeweed 14
Prunus Pensylvanica 20
Prunus serotina 20
Prunus virginiana 20
Pteridium aquilinum 10
Purple cockle 16
Ragwort 34
Rape 19
Ranunculus abortivus 18
Ranunculus acris 18
Ranunculus scleratus 18
Rye, wild 36
Sandbur 36
Saponaria officinalis 16
Saponaria vaccaria 16
Senecio jacobaea 34
Sium suave 26
Snakeroot, white 31
Sneezeweed 34
Spurges 23
Squirrel corn 18
Tobacco, indian 31
Triglochin maritima 13
Water hemlock 25
Water parsnip 26
White snakeroot 31
Whorled milkweed 29
Wild barley 36
Wild rye 36
Xanthium spp. 34

BULLETIN 509 SEPTEMBER, 1955

BEEF HUSBANDRY IN ONTARIO

ONTARIO DEPARTMENT OF AGRICULTURE

PARLIAMENT BUILDINGS, TORONTO, CANADA

CONTENTS

Page

INTRODUCTION 1

BREEDING 6

NUTRIENT REQUIREMENTS OF BEEF CATTLE 11

FEEDING STANDARDS 19

MANAGEMENT 29

PASTURE 40

HOUSING AND EQUIPMENT 47

HERD HEALTH 54

MARKETING 62

BEEF HUSBANDRY IN ONTARIO

This bulletin has been prepared by a committee consisting of staff members of the Ontario Agricultural College, the Ontario Veterinary College, and the Live Stock Branch of the Ontario Department of Agriculture.

FOREWORD

Choice roast beef is a favourite with all persons who profess to be connoisseurs of good food. This popular staple in the human diet is the product of cattle which have been well bred and which have been fed an adequate and well-balanced diet.

The future prosperity of the beef cattle industry depends upon the decisions which consumers make with respect to their choice of meat. In view of their present attitude, it is reasonable to assume that they will continue to demand a product of high quality. Such being the case, it is important that producers make every reasonable effort to cater to their tastes.

In order that producers may have an opportunity of obtaining the latest information on the subject, the committee has included a detailed outline of those practices which have a definite bearing on the production and marketing of beef cattle, and sincerely hopes that it will prove helpful in assisting them in producing a high quality product at a relatively low cost.

INTRODUCTION

SOURCE OF CANADA'S BEEF SUPPLY

On June 1, 1954, Canada's cattle population was estimated to be 9,954,000 head. Of this number, 4,763,800 were classified as females, two years old and over. Since the majority of the animals in this group were being kept for breeding purposes, they constituted Canada's basic herd as of that date. An analysis of this basic herd reveals that 67.9% were being kept mainly for milk purposes, and 22.1% were being kept mainly for beef purposes.

On the same date, Ontario's cattle population was estimated to be 3,011,000 head, or 30.2% of the Canadian total. Of the 1,357,000 females, two years old and over, 77% were being kept mainly for milk purposes, while only 23% were being kept for beef purposes.

In compiling these figures, statisticians are inclined to classify all cows which are milked, including those of beef type, as animals being kept mainly for milk purposes. Under the circumstances, it would scarcely be correct to state that the percentage of dairy cattle in Canada or in Ontario is as great as the figures indicate. Nevertheless, it is fairly obvious that animals of the dairy breeds predominate in our cattle population, and particularly in that of the Province of Ontario.

Even so, every cattle owner is obliged to be interested in the beef industry —the outright beef producer—because he plans to obtain the major portion of his income from the sale of the natural increase in his herd; the dairyman because he must resort to this industry as an outlet for his old cows and surplus stock which cannot be sold for breeding purposes.

BEEF RAISING IN ONTARIO

Ontario farmers derive approximately 70% of their cash income from the sale of live stock and live stock products. Cattle sales usually account for 15 to 18% of the total. In view of the fact that cattle can be sold at various ages and weights, beef production does not follow any standard pattern as does hog production where the objective is to produce a hog of bacon type which will carry the optimum degree of finish when marketed at 200 pounds.

Purebred breeders occupy the key position in that they strive to produce breeding stock which will be capable of improving the commercial herds if given the opportunity. For the most part, their standards are established in the show rings, where breeders vie with one another in the production of animals that will receive the approval of judges who, incidentally, are well versed in the characteristics which combine to make up a good animal both from the standpoint of the breeder and of the commercial producer.

Ontario is fortunate in having a large number of progressive purebred breeders. In 1954, Ontario membership in the various beef breed associations was as follows:

(1)	Canadian Shorthorn Association	1,564
(2)	Canadian Hereford Association	1,233
(3)	Canadian Aberdeen Angus Association	366

A group of choice feeder calves exercise

Despite the importance of this group, the great majority of Ontario beef producers maintain grade herds and conduct their operations in the following ways:

(1) Dual-Purpose Herds

In view of the fact that rural Ontario is characterized by relatively small farms ranging in size from 100 to 200 acres, the majority of persons interested in beef cattle combine dairying with beef production. The cows, including many of beef type, are milked regularly, and provide a steady source of income through the sale of cream. The skim milk is utilized for raising calves, pigs and chickens. In most instances, the natural increase is sold as two-year-olds, after having been finished either on grass or in the stable. In either case, a considerable portion of the body weight is produced on pasture.

(2) Stable Finishing of Purchased Feeders

In some sections of Ontario, particularly in the south-western part, a very large acreage is devoted to the production of cash crops. Farmers engaged in this type of enterprise recognize the advisability of following a system of crop rotation which includes the seeding of each field to grass at regular intervals and of having some field in grass every year. Since a large acreage of these farms is devoted to cash crops, it is not always convenient to maintain a breeding herd or to keep purchased cattle during the summer months. As a consequence, these operators buy feeder cattle in the fall, and use them to convert roughage and grain into beef during the winter. By following this practice, they are making maximum use of crops and by-products that might otherwise be wasted. In addition to producing beef, the soil fertility is maintained by the manure from the feeding enterprise.

During each of the past few years, imports of feeder cattle from Western

Canada have ranged from 80,000 to 130,000 head. Although many are purchased by cash crop growers, persons engaged in mixed farming buy a fair percentage to supplement their supply of home-produced feeders.

(3) Grass-Finishing Stockers

During the early part of the century, and particularly in the depression years, a great many farms that had been brought into cultivation by the early settlers were abandoned. The buildings and fences soon deteriorated, and the land reverted to natural grass. In recent years, these properties have been acquired by persons primarily interested in grazing cattle, usually purchased in the late winter for spring delivery. If the cattle have been on full feed, they will probably be placed on pasture for eight or ten weeks and will continue to receive a heavy grain ration, the objective being to produce maximum gains and, at the same time, preserve a high degree of finish. Thus, owners are in a position to market their cattle at the time which seems most opportune. In other cases, thin cattle are purchased in the spring. Usually, these cattle have been wintered on roughage and have developed large frames; hence they make rapid gains when turned on grass. However, they do not acquire a high degree of finish until late in the season, at which time they may be marketed for immediate slaughter or for short-term stable feeding.

(4) Baby Beef Production

As the term implies, baby beef is tender, juicy beef—the product of young, well-finished cattle. In its production, the calves are usually allowed to nurse their dams. As weaning time approaches, they are started on solid feed, and are on full feed as soon as is practicable after being separated from their dams. As a general rule, baby beef calves are marketed at ages ranging from thirteen to sixteen months, at which time they should weigh from 700 to 1,000 pounds.

In a few instances, cheese factory patrons are engaging in baby beef production. Their dairy cows are mated to bulls of a beef breed. Inasmuch as these cows will usually produce more milk than one calf can consume, two calves are allowed to nurse each cow. This practice allows fifty per cent of the cows in the herd to be milked in the regular way, while the balance are used as nurse cows. This plan is practicable only when all cows in the herd freshen at the same season of the year. These cross-bred calves are not as thick and low set as calves of "straight" beef breeding; however, if well finished on grain, their carcasses are quite acceptable to the trade.

Several years ago, a group of farmers residing in south-western Ontario who owned commercial herds of Aberdeen Angus organized themselves into an association which has become known as the "Red Triangle Baby Beef Association". Their objective is to produce top quality baby beef and to have it merchandized under the special brand name, "Red Triangle Baby Beef". These producers market their calves through one packing plant on a dressed weight and grade basis. They receive the selling prices of the carcasses, plus the value of the by-products, less a nominal charge for slaughtering and selling.

Baby beef production varies with the price of cattle. When prices are high, there is a tendency for producers to let the calves do the milking, particluarly if labour is difficult to obtain; but when prices are low, producers are inclined to get all the revenue they can from their herds, and hence to switch to the prac-

Feeder cattle being sold at the Manitoulin Feeder Cattle Sale

tice of milking cows and raising the calves on skim milk. Regardless of the trends which occur, baby beef accounts for a relatively small percentage of our total beef supply.

(5) Production of Feeder Cattle

The land in certain parts of Old Ontario and most districts of Northern Ontario is capable of producing grass and hay, but is not entirely suitable for the production of grain. In view of the fact that any sound program of beef production must be built around maximum utilization of home-produced feed, persons residing in those areas must, of necessity, be primarily concerned with the raising of feeder cattle. Manitoulin Island is the principal producer of this type of stock. Previous to 1944, marketing was disorganized, and maximum returns were seldom realized. However, in that year, Ontario's first feeder cattle sale was held, and was so successful that a sale has been staged in each succeeding year. This sytem of selling has greatly benefited the producers, and has provided buyers with an excellent medium for purchasing uniform carloads of well-bred stock. In 1950, cattle raisers in the Algoma district organized and staged their first sale. Producers in Muskoka and Parry Sound followed their example in 1953. This may become the standard method for selling feeder cattle in northern districts, particularly if the quality continues to improve.

WHAT IS THE BEST PRACTICE TO FOLLOW?

Every farmer is faced with the fact that his financial returns are derived from the top six inches of the soil. The amount of those returns depends upon the volume of production per acre and the method of marketing the crops produced. In Ontario, where people enjoy a relatively high standard of living, maximum returns are invariably secured when the natural products of the soil are marketed through live stock. In normal times, the beef producer who is located on a small acreage is obliged to supplement his income from the sale of cattle by engaging in the dairy business to the extent of selling cream. On the other hand, the producer with a large acreage can obtain an adequate income from his beef herd without having to milk cows.

The farmer who expects to derive most of his revenue from the sale of cash crops is interested in beef cattle as a means of utilizing feed that might otherwise be wasted. Conservation of the soil, and not necessarily profit from the beef enterprise, is his first consideration. Hence, these men are well advised to buy feeder cattle. Those who live in areas where hay and grass predominate have little alternative except to raise feeder cattle. It would appear that there is no best practice to follow. Nevertheless, beef production is sufficiently diversified to permit each interested person to choose the practice best suited to his particular farm.

BREEDING

1. CONSIDERATIONS IN ESTABLISHING A BEEF HERD

(a) Take stock of resources

Before establishing a beef herd, the prospective investor should take stock of his cattle-producing resources. Unless pasture and roughage can be produced abundantly and at a relatively low cost, the project should be abandoned. As a general rule, wise decisions are based on the amount of land available for pasture production. The practice of finishing cattle in stables or feed-lots should be confined to farms where pasture is not included in the crop rotation, or to farms where other stock such as dairy cattle or sheep compete for the pasture that is available.

This does not necessarily mean that the raising of beef cattle must be confined to large tracts of cheap land. Nevertheless, if expensive land is used, the pasture area should have a high carrying capacity, and a considerable portion of the remaining land must be capable of producing heavy yields of forage crops.

All beef cattle enterprises require manual labour; however, this can be kept to a minimum if building arrangements and equipment installations promote convenience and allow for the maximum use of power machinery. Since there is less irksome labour associated with the production of beef cattle than with most other classes of live stock, it is usually easier to find competent help.

Insect pests may be a deterrent to the raising of live stock in some of the north-western bush sections of Ontario but, generally speaking, neither insects nor diseases are limiting factors to beef production.

(b) Which breed should be selected?

Many commercial beef herds contain few cows which are eligible for registration. Usually, these herds are graded up by the use of a succession of bulls of one breed, and are described as "grades" of that breed. There are three main beef breeds—Scotch Shorthorns, Herefords and Aberdeen Angus. In addition, Dual-Purpose Shorthorns and Red Polls are used in beef production. No one breed is "the best" for Ontario, or even "the best" for a given locality. Usually, the breed most frequently found in any area is there because it is well suited to local conditions; nevertheless, another breed might perform just as well in a similar environment. If satisfactory breeding stock can be obtained, it is a wise plan to select the breed which is common to the locality, as this practice tends to establish uniformity among the herds in the community.

Some individuals have a personal preference for a particular breed. Such persons will derive satisfaction from working with representatives of the breed of their choice, and will probably develop into more successful beef producers than would have been the case if they had chosen the breed common to the neighbourhood.

(c) Size of the Herd

Usually, the size of a herd is governed by the amount of pasture, the feed supply, and the financial resources. The latter factor is the least important, since herds can be built up to the capacity of the farm by natural increase.

When a beef cattle herd is being maintained as the sole source of income, it should contain not less than twenty-five breeding females. Herds maintained for feeder cattle production should be approximately double that size, while dual-purpose herds, which provide two sources of income, should comprise at least twelve to fifteen cows.

If the cattle enterprise is not the sole revenue producer on the farm, herds of these sizes should be considered as the smallest units feasible for economical production, owing to the fact that labour requirements do not diminish to any significant extent when herd size is reduced below these levels.

(d) Selection of Breeding Females

Since success or failure in beef production depends to a great extent on the choice of breeding females, a beginner is well advised to seek the guidance of an experienced man in his locality.

Although uniformity in breed characteristics is highly desirable, good beef type is of greater importance. All females selected should be deep, thick, low-set, healthy and vigorous. Strong bones, straight legs and a full heart girth are indicative of good wearing qualities and a strong constitution, while such characteristics as smooth, natural fleshing, and a mild temperament are usually associated with "good doers".

In too many instances, udders are overlooked. Although not as heavy milkers as representatives of the dairy breeds, beef cows should show indications of being able to produce sufficient milk to feed their offspring. As the name implies, dual-purpose cows perform a function in both beef and milk production; consequently, even more attention should be paid to their mammary development.

(e) At what age should females be purchased?

The age at which females are purchased as foundation stock is usually governed by the amount of capital available. While the outlay for calves is less than for other age groups, the beginner must realize that he will not obtain any income for at least three years. In the interval, expenditures must be made for the maintenance and development of the herd.

Well grown yearlings can be bred to calve the following spring, thus giving a return to the enterprise within approximately two years. Occasionally, yearlings bought as open heifers prove to be with calf. Inasmuch as yearling or two-year-old heifers have a life's productivity ahead of them, they should be given serious consideration by persons selecting foundation females.

Young cows are not easily obtained, except through dispersal sales. Open cows sent to market may be "shy" breeders. Furthermore, they frequently carry a lot of unnecessary finish. Quite often, a beginner can purchase two or three good breeding females from each of several farmers in the district, thereby assembling the nucleus for a herd.

Occasionally, a start has been made in beef cattle production through the purchase of range cows which are still young enough to have a few more years of usefulness under Ontario conditions. At times, medium-quality purebreds can be bought for very little over market price from breeders who are reducing their herds. If regular breeders, such animals are quite acceptable as foundation stock in commercial herds.

(f) What price should be paid for breeding stock?

Stocker females of good quality can be purchased at stock yards, or public auctions, or direct from owners. When cattle are bought at a stock yard, the transaction is usually made on a price-per-pound basis, the price being set by supply and demand. On the other hand, if purchases are made at auction or by private agreement, the buyer is well advised to keep current market quotations in mind and conduct his negotiations accordingly.

He should also remember that a calf should weigh at least 400 pounds at weaning time, a yearling 650 to 750 pounds, a two-year-old from 850 to 1,000 pounds, and a mature beef cow 1,100 pounds and up. Some premium can be paid for cows which appear to have better-than-average quality, or which have been acclimatized to the area.

Prices are generally lowest in the fall, but the buyer must consider the cost of wintering and remember that winter losses in medium-sized and large herds usually average about two per cent for calves and one per cent for older stock.

(g) Selecting replacements

Cows which are hard to get with calf and cows which raise poor calves should be replaced with heifers from the best producing cows. Although most live stock breeders are tempted to sell their growthiest and fleshiest heifers, they should exercise some restraint. By yielding to the temptation, they are disposing of their best herd prospects and limiting their future profits. While the bull may be half the herd, the females represent the continuing half.

2. SELECTION OF THE HERD SIRE

If steady improvement is to be made, each successive sire must be better than the cows in the herd. The bull should be a representative of the breed which the operator had as his objective when selecting the foundation females. A succession of good sires from this breed, coupled with retaining the better female offspring and the culling of older stock, will contribute to the development of a fine herd having the general characteristics of the breed selected.

Bulls used on commercial herds should be low-set, deep at the heart and flank, full in the heart girth and middle, wide in the chest, loins and pins, level over the rump, deep and full in the round, and strong and straight in the legs. They should possess mellow, natural fleshing, and be healthy and vigorous. Breed character should reveal indications of strength, alertness and a mild disposition.

Purebred beef bulls can be tested under the Advanced Registry Policy which makes provision for rating them on the performance of four of their offspring. Three factors are considered in the test, namely, rate of gain, economy of gain and carcass quality. Sires of high performing progeny are in demand by purebred breeders, and their sons make excellent prospects for commercial herds.

A group of A. R. test calves taking their morning exercise

Bulls may be proven in a practical way through normal use. The effectiveness of older males can be determined by examining their offspring. A neighbour may have a good breeding sire which he wishes to exchange for one having similar desirable characteristics, or which he is prepared to sell at approximately "bologna" price because the daughters are old enough to be bred. Bulls of known performance may also be purchased at purebred or commercial dispersal sales. On the average, the proven bull is the most reliable herd improver. Inasmuch as some bulls refuse to breed, or become infertile as they advance in age, the purchaser must insist upon a guarantee that the old bull is a regular breeder.

3. ARTIFICIAL INSEMINATION

There are sufficient licensed artificial insemination centres in Ontario to serve all sections of the Province. All centres are in a position to provide service for beef herds. By making use of this service, breeders can reduce costs considerably, particularly in herds of less than fifteen cows. The capital outlay, which is usually equivalent to the value of two steers, and the cost of the feed consumed by the bull are eliminated. Furthermore, the small herd owner is provided with the service of a much better bull than he can afford to purchase. If a high rate of conception is to be obtained, the cows must be inspected for the onset of heat once or twice daily during the breeding season. Unless the herd owner is prepared to take this precaution and follow it up by promptly calling the technician, he may be disappointed in his results.

4. CROSSBREEDING

The term "crossbreeding" is used to describe a systematic plan of crossing involving two or more breeds of cattle. The simplest method is known as crisscrossing. It involves the use of a sire of a different breed than the one used in grading up the foundation herd. The daughters resulting from this mating are bred back to a sire of the breed originally selected. In each succeeding generation, sires of alternate breeds are used.

Sires of three breeds may be used in a circuitous system. Under this method, sires of different breeds are mated to the females of each generation for three generations; then this routine is repeated over and over again. Increasing the number of breeds is of doubtful value, and breaking the pattern can lead to "mongrelization".

Since crossbreeding promotes hybrid vigour, crossbred females are usually growthier and become better mothers than "straight bred" stock. The blue-grey steers of Scotland, produced from a cross of the Shorthorn and the Aberdeen Angus breeds, are renowned as good feeders and carcass animals.

There are two drawbacks to the practice. Firstly, two or more sires, each representing a different breed, must be available; secondly, the colour pattern, an important consideration with some buyers, is broken. Artificial insemination is particularly useful where the breeder wishes to practise crossbreeding, since the services of bulls of two or three beef breeds can be obtained from most centres.

NUTRIENTS REQUIRED BY BEEF CATTLE

Feeds for beef cattle must supply energy, protein and certain vitamins and minerals, and these requirements must be kept in mind in planning and following a feeding program.

(1) Energy

Energy is required in large amounts for growth, lactation, reproduction and fattening, as well as for the obvious requirements for physical activity and for keeping the body warm. Insufficient energy supplies to young animals will result in poor and uneconomical weight gains. The process of fattening animals involves the feeding of an excess of energy nutrients so that fat is deposited throughout the body. Satisfactory reproduction demands adequate energy intake, and lactation demands an added intake for the formation of the fat and sugar in milk.

Energy is obtainable from carbohydrates, proteins and fats in feedstuffs, but the most plentiful and economical source of energy for cattle is the carbohydrate portion of the feed, including both the nitrogen-free extract (starches, sugars) and the fiber (cellulose) fractions. The action of the micro-organisms in the rumen enables cattle and other cud-chewing animals to digest much of the fiber consumed. The feeds high in fiber are known as "roughages", and this class includes pastures, hays and silages, as well as corn fodder, stover, corn cobs, and hulls of grains and other seeds. Feeds, such as grains, which are high in sugars and starches but low in fiber are known as energy "concentrates".

The term, Total Digestible Nutrients (T.D.N.), used to express the energy value of a feed, includes all the digestible carbohydrates, protein and fat (the latter being multiplied by 2¼ since it has a higher energy value than the others). The higher the T.D.N. value is, the higher the energy content of a feed.

(2) Proteins

Proteins are complex nutrients containing nitrogen in a special combination. They are absolutely essential to life in all animals for the formation of muscles, organs, bones, milk and certain other body compounds. The requirement is greatest during periods of rapid growth, reproduction and lactation.

If the growing animal is not provided with enough protein to meet the heavy demands for new tissue, growth will be slowed down. Early and rapid gains are usually the most economical, and sufficient protein to permit of this type of growth should be made available. It is well to bear in mind, however, that protein is usually the most expensive nutrient item, and the feeding of more than required is rarely economical.

In pregnancy, the cow requires a protein intake sufficient for building the body of her calf in addition to her own maintenance; and in lactation, the requirement is even greater to provide the large amounts of protein which the milk contains.

Some animal species (e.g. poultry and swine) are very exacting in their requirements for specific "high quality" proteins. Fortunately, protein quality is not a problem with cattle. The bacteria in the rumen are able to manufacture good quality protein for the cow from poor quality protein in the feed and, to some extent, from certain other nitrogen containing substances which are not proteins. For example, the chemical substance, urea, can be used to replace a limited portion of the protein in cattle rations. Practically the only consideration in protein-carrying feeds for cattle is the digestibility of the protein contained therein, the proportion of the protein which is digestible varying from one feed to another.

(3) Vitamins

Vitamins are a special class of nutrients required by animals in amounts which are very small in comparison with such substances as carbohydrates and proteins. Nevertheless, their presence in such amounts is essential for the health and performance of the animal. The many vitamins involved in life processes have individual functions to perform, but in general they can be described as regulators of body processes.

Only two vitamins, A and D, require attention in cattle feeding. The rumen bacteria manufacture vitamin K and all the vitamins of the B group, and these are not required from outside sources after the first two months of life. Prior to this, the calf obtains these vitamins from milk. There is no evidence that supplements of vitamin E are required by cattle on usual rations containing good green feed and some whole grains.

(a) Vitamin A

Vitamin A is obtained from the feed in the form of carotene, a yellow colouring material which the animal changes into colourless vitamin A within its body. Some of the vitamin A, the surplus over the cow's requirement for its own body activities, is stored in the liver and the body fat. Variable amounts of unchanged carotene also occur in these places, giving the yellow colour to fat.

This vitamin is required for growth, for the maintenance of a healthy condition in the tissues of the digestive tract, the respiratory organs and the eyes, and for successful reproduction and lactation. Shortages of vitamin A will cause poor growth, and extreme deficiencies will lead to night blindness, sore eyes, staggering, poor muscular control and reproductive troubles. More common than severe shortages will be slight or border line deficiencies which will cause lowered performance in growth, lactation and reproduction.

The common source of carotene for cattle is green plant material. It is found abundantly in fresh pasture—the younger and leafier the growth, the better the carotene content. Clovers and alfalfa are better sources than grasses under similar conditions.

Dried-up pasture growth is very low in carotene, while sun-cured hay contains less than the fresh crop at cutting time owing to the fact that exposure of dry plant material to sunshine and air readily destroys carotene. The longer the curing period in hay making is, the greater the carotene loss. The newer methods for the barn-drying of hay usually yield hay much higher in carotene than field-curing, since long exposure to sunlight is avoided. A gradual destruction of carotene occurs in hay during storage in the mow. The making of silage from pasture and hay crops, carefully done, will preserve good amounts of the carotene in the crops.

The green colour of hays and silages can be used as a rough guide to their value as carotene sources. The green colour is not carotene, however.

Carotene is found also in yellow corn; hence, the feeding of corn grain or corn and cob meal will make a contribution to the vitamin A nutrition.

The ability of cattle to store some of the vitamin A surplus during periods of excess intake from excellent pasture is very valuable in assisting them through periods of low carotene intake such as drought periods or late winter.

Supplementary vitamin A may be supplied to calves by dry or oily preparations. Fish liver oils, especially those of low potency, should not be used as supplements for milking cows.

(b) Vitamin D

Growing animals require vitamin D for the formation of strong bones and teeth, and adult animals require it for maintaining these structures. The minerals, calcium and phosphorus, which form the major portion of hard bone structure, are not used and deposited properly in the absence of adequate vitamin D. A deficiency of vitamin D results in the condition of rickets in calves, the symptoms of which include swollen joints, lameness and, in later stages, decreased growth, dragging of hind feet and bending or even fractures in bones.

Usually vitamin D is obtained by cattle in two ways: through exposure to sunlight which forms the vitamin in the body, and through feed. Sun-cured plant material contains vitamin D produced through the action of the sun's rays. It should be noted that methods of hay-drying which avoid exposure to sunlight result in higher carotene retention but, at the same time, prevent the formation of vitamin D in the hay. Similarly, forage preserved as silage contains little or no vitamin D.

Calves, especially in the winter, may require a vitamin D supplement in the form of special preparations or dry irradiated yeast mixed with the concentrate.

(4) Minerals

Of the numerous minerals known to be essential for cattle, many are present in the usual feeds in ample amounts, and only the following may require special attention: calcium, phosphorus, salt (sodium chloride), iodine and cobalt. The use of supplements to supply minerals other than these cannot be recommended for general use at present. The possibility exists that deficiencies in one or more other trace minerals may occur in certain localities.

(a) Calcium and Phosphorus

Calcium and phosphorus are discussed together since their utilization in the body is related and, in some of the supplementary sources, they occur together. These two are the main mineral constituents of bones and teeth, and the demand for them is very great during growth and in pregnancy to provide for the manufacture of new bony structures. Since milk is very rich in both calcium and phosphorus, larger quantities of both are required during lactation.

Insufficient supplies of either or both of these minerals will cause defects in bones resembling those described for vitamin D deficiency, i.e. rickets and eventual growth slow-down in calves, and weakened bones in adult animals. Serious phosphorus shortages in rations give rise to some other characteristic effects. Appetite is decreased and, as the deficiency progresses, the animals may show a "depraved" appetite which causes them to chew bones, wood or dirt.

The recommended daily calcium intake for growing steers and heifers ranges from a high of 20 grams in the early stages to 15 grams near maturity; the recommended phosphorus intake is 15 grams per day throughout. For maintenance of mature cows, intakes of 16 grams of calcium and 15 grams of phosphorus per day are recommended. In fattening animals, it is recommended that 20 grams of calcium and from 15 to 20 grams of phosphorus per day be provided. The highest daily amounts, 30 grams of calcium and 24 grams of phosphorus, are recommended for lactation. These figures, the most recent recommendations of the United States National Research Council, are the daily intakes per head.

Cattle rations in Ontario are likely to show a greater deficiency in phosphorus than in calcium as a result of fairly wide-spread phosphorus deficiency in Ontario soils and in the crops grown on these soils. Forages in general are low in phosphorus; grains and seeds are higher, while legumes are richer in calcium than the grasses. Milk is the main source of calcium and phosphorus for calves. In older animals, the need for calcium supplements will be dependent upon the quality of the roughage fed and especially upon the amount of legumes included. As for phosphorus, it is doubtful if the requirements can be met without the use of supplements, except under conditions of extremely heavy feeding of concentrates.

Calcium and phosphorus are supplied by supplements of bone meal, dicalcium phosphate, monocalcium phosphate and *defluorinated* rock phosphates. Disodium phosphate supplies phosphorus only; limestone provides calcium only. Various trade names are applied to these products by manufacturers. The best procedure is to blend the supplements with salt and to mix a definite proportion (one or two per cent) with the home-mixed concentrate, and also to allow the animals free access to the mineral mixture in a separate covered box. If a commercial concentrate containing minerals is used, the mixing of additional minerals is unnecessary. The practice of keeping a mineral mixture in a covered box where the animals can help themselves is still advisable, however.

(b) Salt, Iodine, Cobalt

Common salt (sodium chloride) is an important requirement of beef cattle. It performs many functions in the body in addition to acting as a condiment, improving the palatability of other feeds and supplements and stimulating appetite.

Iodine, although required in very small amounts, is a very vital mineral, and is essential for the activity of the thyroid gland which is the master control for all body processes. Deficiency of iodine leads to goitre or "thick-neck", particularly evident in calves, and can lead to the birth of calves which are weak or dead as well as goitrous. A supplement is recommended for Ontario feeding conditions, and the most convenient and satisfactory procedure is the use of iodized salt.

Within recent years, it has been found that crops in some areas of Ontario are low in cobalt, and cattle feeding on them may not receive enough of this mineral unless a supplement is fed. A deficiency leads to unthrifty, listless animals which show gradual loss of appetite, weight loss, rough coats and anemia.

A depraved appetite similar to that of phosphorus deficiency may develop and reproductive troubles may be encountered.

The small amount of supplementary cobalt required can be best supplied in the form of cobaltized salt. Its use is recommended for all Ontario cattle.

The iodized and cobaltized salt may be mixed with concentrates and with other minerals, as well as supplied separately, preferably in a box which protects it from the weather.

Daily salt consumption will range from ½ ounce to 1¼ or 1½ ounces per head.

(c) Mineral Supplements and Mixtures

Various combinations of the suggested calcium and phosphorus supplements and salt* may be used to meet particular needs. Some suggested mixtures are given below:

A. 50 pounds Steamed Bone Meal, 25 pounds Disodium Phosphate, and 25 pounds Iodized Cobaltized Salt.
B. 50 pounds Feeding Bone Meal, 25 pounds Monocalcium Phosphate, and 25 pounds Iodized Cobaltized Salt.
C. 50 pounds *Defluorinated* Rock Phosphate, 25 pounds Disodium Phosphate, and 25 pounds Iodized Cobaltized Salt.
D. 50 pounds Monocalcium Phosphate, 17 pounds Ground Limestone, and 33 pounds Iodized Cobaltized Salt.
E. 67 pounds Feeding Bone Meal and 33 pounds Iodized Cobaltized Salt.

Various other combinations of available supplements may be used with satisfactory results. Average figures for the calcium and phosphorus contents of the common supplements and for the mixtures suggested above are listed on the following page:

(5) Other Additions to Rations

The use of the substance, thiouracil, in cattle rations as an aid to fattening has been suggested, but its use is not allowed in Canada at time of publication. This chemical, by its action on the thyroid gland, slows down the metabolic rate in the animal's body and increases both the amount of fat deposited and the feed efficiency. Its use cannot be recommended at present; future recommendations will depend upon the results of considerably more thorough investigations than have been reported to date.

*It should be borne in mind that the colour of salt blocks containing iodine (red-brown) and cobalt (blue or purple) is due to added colouring substances and not to the trace minerals themselves. The fact that the loose form of iodized and cobaltized salt may not be coloured does not make it inferior nutritionally.

Quite recently, some favourable growth effects have been reported from the use of very small amounts of antibiotics in the feed of certain animals, including calves. Until the effects of this feeding have been more thoroughly investigated and the conditions of use have been defined, the inclusion of antibiotics in rations for calves cannot be recommended for general use. Diethylstilbestrol is another new product that may be incorporated in the rations of the future, but much investigation is necessary before the place of the product in cattle feeding is definitely known.

	Calcium		**Phosphorus**	
	%	**Grams per lb.**	%	**Grams per lb.**
Supplements				
Bone Meal (Feeding)	25.0	113.5	10.9	49.5
Bone Meal (Steamed)	29.1	132.1	14.3	64.9
Dicalcium Phosphate	26.5	120.3	20.5	93.1
Disodium Phosphate	—	—	8.6	39.0
Limestone (Calcite)	38.3	173.9	—	—
Monocalcium Phosphate	16.0	72.6	24.0	109.0
Phosphate with Colloidal Clay	20.0	90.8	10.0	45.4
Rock Phosphate (*Defluorinated*)	27.0	122.6	13.4	60.8
Mixtures				
A	14.6	66.4	9.3	42.2
B	16.5	75.0	11.45	52.0
C	13.5	61.3	8.9	40.4
D	14.5	65.9	12.0	54.6
E	16.8	76.3	7.3	33.2

AVERAGE COMPOSITION OF FEEDING STUFFS AS FED

Feeding Stuff	Dry Matter %	T.D.N. %	Digestible Protein %	Crude Protein %	Fat %	Fibre %	N.F.E. %	Calcium %	Calcium grams per lb.	Phosphorus %	Phosphorus grams per lb.
Pastures and Green Feeds											
Alfalfa	25.3	14.7	3.4	4.5	0.9	7.2	10.4	0.35	1.59	0.07	0.32
Alfalfa and Brome Grass (half alfalfa)	22.4	14.6	3.6	4.6	0.8	5.2	9.4	0.3	1.36	0.07	0.32
Alfalfa and Timothy (half alfalfa)	21.7	14.1	3.4	4.3	0.8	4.5	9.7	0.3	1.36	0.07	0.32
Blue Grass, Kentucky	30.2	19.2	3.9	5.5	1.2	7.6	13.4	0.16	0.73	0.13	0.59
Clover, Ladino	16.3	11.4	3.7	4.4	0.4	2.2	7.1	0.2	0.91	0.07	0.32
Clover, Red, before bloom	18.7	13.3	3.2	4.3	0.6	2.6	9.2	0.36	1.63	0.06	0.27
Clover and Mixed Grasses	20.0	13.9	3.4	4.5	0.8	3.6	9.6	0.23	1.04	0.07	0.32
Clover, Sweet, before bloom	20.8	12.8	3.2	4.1	0.7	4.9	9.2	0.34	1.54	0.10	0.45
Corn Fodder, Dent, tassel stage	15.0	9.7	1.0	1.6	0.3	4.2	7.8	0.06	0.27	0.05	0.23
Grasses, Mixed, young	29.7	20.5	3.8	5.1	1.5	6.3	13.8	0.15	0.68	0.09	0.41
Kale	11.8	8.0	1.9	2.4	0.5	1.6	5.5	0.19	0.86	0.06	0.27
Millet	24.7	15.6	1.2	2.0	0.6	7.4	12.9	0.10	0.45	0.06	0.27
Oat Pasture	14.0	9.1	2.4	3.2	0.6	2.8	5.4	0.06	0.27	0.09	0.41
Oats and Peas	22.5	14.3	2.4	3.2	0.9	6.3	10.2	0.17	0.77	0.07	0.32
Rye Pasture	19.7	13.2	4.0	5.4	0.9	3.5	7.4	0.13	0.59	0.10	0.45
Sudan Grass	21.6	14.3	2.4	3.3	0.6	5.6	10.2	0.12	0.54	0.10	0.45
Timothy	23.9	15.4	3.5	4.7	0.9	4.6	11.1	0.14	0.64	0.09	0.41
Silages											
Alfalfa, wilted, no preservative	36.0	21.3	4.1	6.0	1.4	11.7	13.7	0.51	2.32	0.12	0.54
Clover (Ladino) and Timothy	29.7	17.9	3.8	6.0	1.6	6.9	12.3	0.36	1.63	0.06	0.27
Clover, Red	30.9	18.3	2.6	4.0	0.9	10.2	13.4	0.50	2.27	0.07	0.32
Clover and Mixed Grasses	36.0	22.7	2.6	4.4	1.1	11.0	16.4	0.29	1.32	0.12	0.54
Corn, Dent, well-matured	27.4	18.1	1.2	2.2	0.8	6.7	16.1	0.10	0.45	0.06	0.27
Grass Silage, considerable legumes	33.3	19.1	2.9	5.2	1.3	8.7	14.2	0.25	1.14	0.12	0.54
Timothy, not wilted, grain added	33.1	19.2	2.3	4.0	1.1	10.4	15.6	0.19	0.86	0.11	0.50
Roots											
Mangels	9.2	7.0	0.9	1.3	0.1	0.8	6.0	0.01	0.05	0.03	0.14
Sugar Beets	16.4	13.7	1.2	1.6	0.1	1.0	12.6	0.04	0.18	0.04	0.18

AVERAGE COMPOSITION OF FEEDING STUFFS AS FED (Continued)

Feeding Stuff	Dry Matter %	T.D.N. %	Digestible Protein %	Crude Protein %	Fat %	Fibre %	N.F.E. %	—Calcium—		—Phosphorus—	
								%	grams per lb.	%	grams per lb.
Hays, Other Dried Roughages											
Alfalfa	90.5	50.3	10.5	14.8	2.0	28.9	36.6	1.47	6.67	0.24	1.09
Alfalfa Meal (dehydrated)	93.6	54.7	13.8	18.9	2.8	24.3	38.1	1.50	6.81	0.35	1.59
Alfalfa and Brome Grass	89.3	46.8	7.2	12.4	2.0	28.6	38.1	0.74	3.36	0.24	1.09
Alfalfa and Timothy	89.8	49.1	6.6	11.1	2.2	29.5	40.3	0.81	3.68	0.21	0.95
Clover, Ladino	88.0	54.9	14.2	19.4	3.2	20.7	34.9	1.32	5.99	0.29	1.32
Clover, Red	88.1	52.2	7.1	11.8	2.6	27.2	40.1	1.35	6.13	0.19	0.86
Clover and Timothy	88.1	51.2	4.8	8.6	2.2	30.3	41.2	0.68	3.09	0.20	0.91
Corn Fodder	91.1	58.8	3.8	7.8	2.2	27.1	47.6	0.24	1.09	0.16	0.73
Corn Stover (ears removed)	90.6	51.9	2.1	5.9	1.6	30.8	46.5	0.29	1.32	0.05	0.23
Millet	90.3	50.7	5.6	9.3	2.2	23.9	47.6	0.29	1.32	0.16	0.73
Mixed Grass Hay	89.0	51.7	3.5	7.0	2.5	30.9	43.1	0.48	2.18	0.21	0.95
Straw, Oat	89.7	44.7	0.7	4.1	2.2	36.1	41.0	0.19	0.86	0.10	0.45
Straw, Wheat	92.5	40.6	0.3	3.9	1.5	36.9	41.9	0.21	0.95	0.07	0.32
Timothy	89.0	48.9	2.9	6.5	2.4	30.2	45.0	0.23	1.04	0.20	0.91
Grains, Seeds, By-Product Concentrates											
Barley	89.4	77.7	10.0	12.7	1.9	5.4	66.6	0.06	0.27	0.37	1.68
Beet Pulp (dried)	90.1	67.8	4.3	9.2	0.5	19.8	57.2	0.67	3.04	0.08	0.36
Brewers' Grains (dried)	92.3	61.8	16.8	23.4	6.4	16.1	42.5	0.19	0.86	0.33	1.50
Corn, Yellow	87.0	82.0	6.8	8.8	4.0	2.1	70.9	0.02	0.09	0.28	1.27
Corn and Cob Meal	86.1	73.2	5.3	7.3	3.2	8.0	66.3	—	—	0.22	1.00
Corn Gluten Feed	90.9	76.0	21.9	25.5	2.7	7.6	48.8	0.48	2.18	0.82	3.72
Cottonseed Meal	92.8	70.6	32.8	41.5	6.3	10.4	28.1	0.20	0.91	1.22	5.54
Hominy Feed	90.4	84.5	8.0	11.2	6.9	5.2	64.2	0.02	0.09	0.50	2.27
Linseed Oil Meal (old process)	91.0	77.2	30.8	35.4	5.8	8.2	36.0	0.39	1.77	0.87	3.95
Linseed Oil Meal (solvent process)	90.4	72.3	31.0	36.9	2.9	8.7	36.3	—	—	—	—
Milk, skim, dried	94.2	80.7	31.2	34.7	1.2	0.2	50.3	1.30	5.90	1.03	4.68
Oats	90.2	70.1	9.4	12.0	4.6	11.0	58.6	0.09	0.41	0.34	1.54
Oats, Light weight	91.3	60.1	8.5	12.3	4.7	15.4	54.4	—	—	—	—
Soybean Oil Meal (expeller)	90.9	78.4	37.2	44.3	5.3	5.7	29.6	0.29	1.32	0.66	3.00
Soybean Oil Meal (solvent process)	90.6	78.5	42.4	46.1	1.0	5.9	31.8	0.30	1.36	0.66	3.00
Soybeans	90.0	87.6	33.7	37.9	18.0	5.0	24.5	0.25	1.14	0.59	2.68
Wheat	89.5	80.0	11.1	13.2	1.9	2.6	69.9	0.04	0.18	0.39	1.77
Wheat Bran	90.1	67.2	13.7	16.9	4.6	9.6	52.9	0.14	0.64	1.29	5.86
Wheat Shorts	88.9	77.4	15.0	17.9	4.2	5.7	56.9	0.13	0.59	0.84	3.81

FEEDING STANDARDS

Feeding standards are tables showing the various amounts of nutrients required by an animal of a specific weight or gaining at a given rate. Many workers have issued feeding standards for various classes of stock. Included here is an abbreviation of Morrison's Feeding Standards for Beef Cattle from his text entitled *Feeds and Feeding*, 21st Edition.

The standards for wintering beef breeding cows provide sufficient nutrients to enable the cows to gain slightly in weight as pregnancy advances.

The standards for wintering beef calves and for wintering yearling cattle provide sufficient nutrients to produce approximately the rates of gain stated in the table.

The standards for growing beef cattle are intended for young cattle that are being grown rapidly throughout the entire period, and not for cattle that are "roughed through the winter", as is the common practice in most sections of the range area.

REQUIREMENTS PER HEAD DAILY

	Dry Matter	Digestible Protein	Total Digestible Nutrients	Calcium		Phosphorus	
	Lbs.	Lbs.	Lbs.	Grams	Lb.	Grams	Lb.
Wintering pregnant beef cows							
Weight 1,000 lbs.	14.2–20.0	.70– .80	7.5–10.5	20	.044	17	.037
Weight 1,200 lbs.	16.3–22.8	.80– .90	8.6–12.0	20	.044	17	.037
Beef cows nursing calves, first 3 to 4 months							
Weight 900-1,100 lbs. . . .	22.0–27.0	1.20–1.40	12.0–15.0	30	.066	24	.053
Growing beef cattle, fed for rapid growth							
Weight 400 lbs.	9.1–11.4	.76– .87	6.2– 7.2	20	.044	15	.033
Weight 600 lbs.	12.4–14.7	.84– .95	8.1– 9.3	18	.040	15	.033
Weight 800 lbs.	15.9–18.3	.90–1.00	9.5–10.9	16	.035	15	.033
Weight 1,000 lbs.	18.6–21.0	.95–1.05	10.6–12.0	15	.033	15	.033
Wintering yearling beef cattle, to gain 0.50 to 0.75 lb. per head daily							
Weight 600 lbs.	11.6–13.3	.67– .75	6.3– 7.2	16	.035	12	.026
Weight 800 lbs.	14.2–16.3	.83– .90	7.7– 8.8	16	.035	12	.026
Calves fattened for baby beef							
Weight 400 lbs.	9.6–12.1	1.05–1.15	7.4– 8.6	20	.044	15	.033
Weight 600 lbs.	13.2–15.8	1.26–1.37	10.2–11.8	20	.044	17	.037
Weight 800 lbs.	16.7–19.3	1.52–1.68	12.6–14.4	20	.044	18	.040
Fattening yearling cattle							
Weight 600 lbs.	15.0–17.6	1.18–1.32	10.7–12.3	20	.044	17	.037
Weight 800 lbs.	17.8–20.4	1.52–1.68	14.1–15.9	20	.044	19	.042
Weight 1,000 lbs.	20.0–23.0	1.71–1.91	16.0–18.0	20	.044	20	.044
Fattening 2-year-old cattle							
Weight 800 lbs.	19.6–22.2	1.46–1.62	14.1–15.9	20	.044	20	.044
Weight 1,000 lbs.	22.0–25.0	1.65–1.85	16.5–18.5	20	.044	20	.044
Weight 1,200 lbs.	24.0–27.0	1.70–1.90	17.0–19.0	20	.044	20	.044

The standards for calves being fattened for baby beef are intended for calves that are placed on feed when weighing 300 to 400 pounds, and are then fattened rapidly for marketing at a weight of not over 900 to 1,000 pounds. The recommendations for fattening yearlings are for well-grown yearling cattle which weigh 600 to 750 pounds when placed on feed, and which are marketed at about 1,100 pounds in weight. The standards for fattening two-year-old cattle are for cattle which weigh about 900 pounds at the start, and are marketed at about 1,200 pounds. During the period when fattening cattle are being gotten on feed, they will consume less nutrients than shown in these standards.

The recommendations for fattening cattle are for animals that are to be fattened rapidly on a liberal amount of grain or other concentrates. Cattle fed a limited amount of concentrates will consume less total digestible nutrients (or net energy) than shown here, and will not make maximum gains.

While feeding standards serve a definite purpose in the preparation of a ration, information of a more detailed nature is needed on the characteristics of individual feeds. Herewith follows a description of the ones which are used most frequently in formulating rations for beef cattle.

1. ROUGHAGES

Roughages are described as coarse, bulky feeds low in total nutrients. While this may indicate inferiority, nevertheless this group is of great importance in cattle feeding because of the volume and relative cheapness of the feeds and also because cattle are able to consume and utilize large quantities of them. For economical beef production, roughages must be used in volume and grains used only to overcome such deficiencies as may be caused by a lack of balance of feed constituents, or a lack of nutrient intake occasioned by the fact that an animal can hold and utilize only so much roughage. In dealing with the composition of feeds, roughages are divided into three groups: pasture and green feeds, silage and succulent feeds, and hay and straw and other dried roughages.

(a) Alfalfa and Clovers

There is a wide difference in the individual crops that come under this heading. In general, whether used as a pasture, silage or hay, they are high in protein (for roughage feeds), high in calcium and low in phosphorus. They have a high yield of protein and total nutrients per acre and, at least in favourable years, produce feed throughout most of the pasture season. When pasturing crops that come under this heading, one must exercise care to avoid loss from bloating and to prevent thinning of the seeding owing to overgrazing.

When the breeding herd is fed alfalfa or clover hay, the protein level of the ration will, under most conditions, meet the requirements as set down in the Feeding Standards. Steers being carried throughout the winter months will make satisfactory growth on good hays from crops of this type. Heavily grain-fed steers, when fed hays made from alfalfa or clover, may show evidence of scouring. Mixed hay might give better results if this condition occurs.

(b) Blue Grass

Blue grass is used primarily as a pasture crop and, as such, makes a firm, strong sod that stands treading well, produces grass early in the spring and usually provides pasture in the fall of the year. Unfortunately, it has two liabilities:

one, blue grass is a relatively low yielder; and two, the plants have a tendency to go dormant or stop growing in midsummer, particularly in a dry season. Fortunately, cattle appear to like the dry residue and, if a reserve of herbage is left from the early spring growth, cattle will do well and fatten on this material. Although the carrying capacity or yield of this crop is not high, many acres of steer pasture are predominantly blue grass.

(c) Timothy and other grasses

Timothy is still the most widely grown plant of the grass type being used both as a hay and pasture crop. In composition, it has the characteristics of all grass, being low in protein and high in fiber if near maturity. It is not as high a yielder as alfalfa or some clovers but is used extensively in hay and pasture mixtures.

Brome grass is a relatively heavy yielding grass and is fairly palatable either as a pasture crop or as hay. Like timothy, its chief use is in mixtures, but unfortunately it is not as easy to sow.

Orchard grass, in some areas, is a heavy yielder of both pasture and hay. To get good quality feed from this crop, it must be carefully handled; otherwise, the pasture is rank and the hay coarse and woody. To get satisfactory results from this crop, the beef man must be equipped to clip the pasture areas and handle the hay crop at the proper time; otherwise, the results will be disappointing.

2. SILAGE AND SUCCULENT FEEDS

(a) Corn Silage

Corn silage is a feed that varies considerably in composition, ranging from high moisture, cold, sour, unpalatable material to fresh-smelling, readily eaten feed containing a large amount of corn. In general, however, the quality of corn silage is good. This feed is variable in composition but is usually low in protein and relatively high in total digestible nutrients for a silage crop. Many of the deficiencies of corn silage can be overcome by feeding it with good alfalfa, clover or mixed hay. In areas where silage corn can be successfully grown, there is no common farm crop that will give the yield of total digestible nutrients per acre. This, plus the fact that corn is a relatively easy crop to ensile and gives good results with all classes of beef cattle, makes it a very important feed in a beef production program.

(b) Grass Silage

Although numerous attempts have been made to change the name of this feed, which is definitely a misnomer, all have failed. Now, the term "grass silage" is applied to silage made from legumes that may contain no grass whatsoever, to silage made from mixtures of legumes and grasses and to that made exclusively from grasses. Obviously, the composition of this type of feed varies with the crop, the stage of maturity, the method of ensiling and whether or not preservatives were used at ensiling time. Despite all these variations, grass silage continues to be used in increasingly larger amounts each year. Ensiling "grass" as a means of controlling pasture, harvesting hay crops during unfavourable weather and using surplus hay crops in grassland farming are proving valuable supplements to the feeding program. When grass silage is fed, some dry feed should be supplied either as hay or grain. To attain a heavy consumption of grass silage, it should be left in the manger or bunk for at least an hour. Frozen, mouldy or spoiled silage of any type should not be used.

(c) Turnips

The acreage sown to root crops in Ontario has diminished greatly over the years. However, in areas where the turnip is grown as a cash crop, the unmarketable turnips are available for live stock feeding. While high in moisture, the dry matter is easily digested and large quantities can be fed safely to breeding animals, to steers on maintenance or even to finishing steers during the early part of the feeding period.

3. CONCENTRATES

Concentrates are defined as rich, condensed feeds, low in fiber and high in digestible material. The use of this term is sometimes confined to protein supplements but, in the broad interpretation, it includes the grains, most of their by-products, meat by-products, milk products and a multitude of carbohydrate-rich or protein-rich feeds. Reference will be made to only a few of the more commonly used grains and some by-products.

(a) Barley

Barley is an important fattening, energizing feed grown generally throughout Ontario. Compared with other concentrate feeds, barley is low in protein and high in total digestible nutrients. If it is fed heavily for a long period, cattle may lose their keenness of appetite for this feed. Using it in a mixture will overcome this drawback.

This grain may be used in the mixture for breeding cattle, finishing fed calves or fattening heavy steers. It has a tendency to put on a hard finish. For this reason, and because it is not highly palatable, barley may not be quite as satisfactory as corn for heavily grain-fed steers. However, because of its adaptability to a very wide area, barley is and will be one of the important steer finishing feeds in this Province.

(b) Corn

Where it can be grown to maturity, corn grain is the leading fattening feed for steers. While the area over which this crop can be grown has been greatly enlarged with the introduction of early maturing hybrids, there are areas where corn has definite limitations as a grain crop. On the other hand, grain corn is grown quite extensively in some of the sections where large numbers of steers are finished.

Corn is low in protein, high in nutrients, and palatable. It can be fed whole or ground, and cattle do not "tire" of a mixture containing a large proportion of corn. For best results in finishing, it should be supplemented with a protein-rich feed and with mineral. The finish on corn-fed-steers is good in texture and colour, and the flavour of the meat is highly desirable.

(c) Corn and Cob Meal

This meal is made by grinding—usually with a hammer mill—the cob and the grain, thus saving the expense of shelling and the inconvenience of getting rid of the cobs. In composition, this product is lower in protein and much lower in total nutrients than the corn grain. There is considerable variation in composition between samples of corn and cob meal caused by stage of maturity, moisture content, proportion of cob to grain, and freedom from or presence of large amounts of mould. The feed can be of very high quality and feeding value, or it may be quite an inferior product.

This feed should be freshly ground. Considerable heat develops in grinding and, if large quantities of this ground material are stored for long periods in bins or bags, the feed tends to become stale and unpalatable.

(d) Linseed Oil Meal

This by-product from the extraction of the oil from flax-seed is known in the trade under many names, such as Linseed Meal, Linseed, Linseed Oil Meal and the commonly accepted term, "Oil Cake". Two forms of this product are on the market: new process with a very low percentage of fat, and old process with a much higher fat content, usually around five to six per cent. Both types contain at least three times as much protein as common grains. Old process "oil cake" is the more satisfactory type of protein supplement for all types of beef cattle. Unfortunately, it is not always available and, at times, the price per unit of protein is higher than in other sources.

(e) Oats

The oat grain is the most extensively grown cereal crop in Ontario. Despite the fact it is no higher in protein than barley and much lower in total nutrients than barley, corn or wheat and, despite the fact it is higher in fiber than all of these feeds, it continues to hold the leading position as a cereal grain for live stock feeding. The explanation for this situation is partly cultural and partly nutritional. Suffice it to say, the oat crop can be grown over a very wide area and crop failures are rare. From a nutritional standpoint, oats are safe and palatable and can be used in grain mixtures for all classes of beef cattle from new-born calves to old cows. Oats vary in composition and those that are much below the standard in weight per bushel are likely to be low in feeding value. On the other hand, high weight per bushel may indicate a good feed or merely a high percentage of hull.

(f) Soybean Oil Meal

This product is a by-product from extracting the oil from soybeans and is one of the richer sources of protein of plant origin. Most of the available soybean oil meal is the product of a process that very thoroughly extracts the oil. While many feeders prefer linseed oil meal, the use of soybean oil meal in beef rations is increasing largely because of the lower price per unit of protein.

(g) Wheat

From a feeding standpoint, there are two distinct types of wheat: the feed grades of western wheat and the soft winter wheats of Ontario. Western wheats are higher in protein than Ontario winter wheat but all wheat grain is high in total nutrients. When the price is low, wheat, particularly Ontario winter wheat, is widely used as a feed.

Feeding troubles sometimes result from feeding wheat alone. Finely ground wheat becomes sticky and pasty when consumed and may cause digestive disturbances. Also, many men feed the concentrate mixture by measure rather than by weight and fail to realize the marked weight increase when wheat is fed. Difficulties with soft Ontario wheat can be overcome by coarse grinding, rolling or crimping. Western wheat will not roll satisfactorily and so must be coarsely ground. Mixing wheat with other grains will overcome most of the difficulties associated with this valuable and nutritious grain.

(h) Wheat Bran

A by-product of the milling of wheat, this bulky, laxative, palatable feed is in keen demand. It is slightly higher in protein and lower in total nutrients than most cereal grains. Bran is one of the richest sources of phosphorus among feeds of plant origin. It is used in regular rations and is in particular demand for the feeding of sick animals and cows at freshening time.

The number of feeds that might be mentioned is very large and a complete discussion of the properties of all would be impossible in this type of publication. Attention should be directed to the fact that the economical feeding of farm animals is based on the intelligent use of home-grown feeds. Pastures, hays, silages and grains, balanced where necessary with protein supplements and minerals, should form the basis of rations for beef cattle.

Mixtures of Grains and Concentrates for Beef Cattle

A. Mixtures containing less than 12% of crude protein suitable for:

1. Wintering beef calves and yearlings which are being fed high quality legume hay or mixed hay containing at least one-half legumes, or
2. Wintering beef calves and yearlings which are being fed grass silage, or
3. Fattening yearlings and 2-year-old beef cattle on good pasture.

I.	Corn	1,850 lbs.
	Linseed oil meal	150 lbs.
	Total	2,000 lbs.

*C.P. = 11.0% **D.P...9.0% ***T.D.N. = 80.5%

II.	Corn and cob meal	1,500 lbs.
	Wheat bran	300 lbs.
	Linseed oilmeal	200 lbs.
	Total	2,000 lbs.

*C.P. = 11.5% **D.P. = 9.0% ***T.D.N. = 72.5%

III.	Oats	1,200 lbs.
	Barley	400 lbs.
	Ont. winter wheat	400 lbs.
	Total	2,000 lbs.

*C.P. = 11.5% **D.P. = 9.0% ***T.D.N. = 73.5%

B. Mixtures containing from 12 to 14% crude protein suitable for:

1. Fattening calves, yearlings and 2-year-old beef cattle being fed medium quality alfalfa, clover and mixed hays, or
2. Calves, yearlings and 2-year-olds which are fed red clover hay as the only roughage.

I.

Oats	1,450 lbs.
Wheat bran	500 lbs.
Linseed oilmeal	50 lbs.
Total	2,000 lbs.

*C.P. = 13.5% **D.P. = 11.0% ***T.D.N. = 75.0%

II.

Ground corn	1,160 lbs.
Oats	500 lbs.
Wheat bran	220 lbs.
Soybean oilmeal	120 lbs.
Total	2,000 lbs.

C.P. = 12.5% D.P. = 10.0% T.D.N. = 75.0%

III.

Barley	1,030 lbs.
Oats	700 lbs.
Wheat bran	270 lbs.
Total	2,000 lbs.

C.P. = 12.5% D.P. = 10.0% T.D.N. = 75.0%

IV.

Corn and cob meal	1,310 lbs.
Wheat bran	500 lbs.
Soybean oilmeal	90 lbs.
Linseed oilmeal	100 lbs.
Total	2,000 lbs.

C.P. = 12.5% D.P. = 10.0% T.D.N. = 72.0%

V.

Barley	1,200 lbs.
Oats	625 lbs.
Linseed oilmeal	175 lbs.
Total	2,000 lbs.

C.P. = 14.0% D.P. = 11.0% T.D.N. = 76.0%

VI.

Oats	800 lbs.
Barley	800 lbs.
Wheat	400 lbs.
Total	2,000 lbs.

C.P. = 12.5% D.P. = 10.0% T.D.N. = 75.0%

VII.

Barley	1,200 lbs.
Oats	800 lbs.
Total	2,000 lbs.

C.P. = 12.5% D.P. = 10.0% T.D.N. = 75.0%

*Crude Protein
**Digestible Protein
***Total Digestible Nutrients

C. Mixtures containing over 14% crude protein suitable for:

1. Beef calves recently weaned, or
2. Fattening yearlings and 2-year-old beef cattle being fed low quality legume or grass hay, or
3. Fattening beef cattle being fed heavily on corn silage.

(Ration V. is suitable as the starting grain for calves but should be eventually replaced by a mixture of oats, corn or barley, wheat bran and oilcake.)

I.

Corn	600 lbs.
Oats	500 lbs.
Wheat bran	500 lbs.
Linseed oilmeal	400 lbs.
Total	2,000 lbs.

C.P. = 17.0% D.P. = 14.0% T.D.N. = 74.0%

II.

Barley	1,000 lbs.
Oats	500 lbs.
Wheat bran	300 lbs.
Linseed oilmeal	200 lbs.
Total	2,000 lbs.

C.P. = 15.0% D.P. = 12.0% T.D.N. = 72.0%

III.

Corn and cob meal	1,220 lbs.
Wheat bran	450 lbs.
Soybean oilmeal	155 lbs.
Linseed oilmeal	175 lbs.
Total	2,000 lbs.

C.P. = 15.0% D.P. = 12.0% T.D.N. = 72.0%

IV.

Barley	800 lbs.
Wheat	300 lbs.
Oats	600 lbs.
Linseed oilmeal	300 lbs.
Total	2,000 lbs.

C.P. = 16.0% D.P. = 13.0% T.D.N. = 71.0%

V.

Oats	1,250 lbs.
Wheat bran	500 lbs.
Linseed oilmeal	250 lbs.
Total	2,000 lbs.

C.P. = 16.0% D.P. = 13.0% T.D.N. = 71.0%

VI.

Corn	1,000 lbs.
Oats	600 lbs.
Linseed oilmeal	200 lbs.
Cottonseed meal	200 lbs.
Total	2,000 lbs.

C.P. = 16.0% D.P. = 13.0% T.D.N. = 77.0%

VII.

Corn	1,500 lbs.
Linseed oilmeal	500 lbs.
Total	2,000 lbs.

C.P. = 15.5% D.P. = 13.0% T.D.N. = 81.0%

Mixture Used in the Advanced Registry Testing of Beef Cattle

Oats (No. 3 C.W.)	700 lbs.
Barley (No. 1 Feed)	350 lbs.
Corn (No. 2 Yellow)	420 lbs.
Wheat (No. 3 to 4 Northern)	100 lbs.
Alfalfa Meal	100 lbs.
Bran	200 lbs.
Linseed Oilmeal (35%)	100 lbs.
Bonemeal (Feeding)	15 lbs.
Limestone (95% carbonate, finely ground, Grade B)	5 lbs.
Salt (Cobaltized)	10 lbs.
	2,000 lbs.

(Oats and barley to be rolled, wheat cracked or rolled, and corn cracked).

This mixture is improved if the alfalfa meal and linseed oilmeal are pelleted. There is less dust.

Extra salt to be provided in exercise paddock.

C.P. = 13.0% D.P. = 11.7% T.D.N. = 73.4%

SUGGESTED RATIONS FOR BEEF CATTLE FEEDING

	Wintering mature beef breeding cows. (Av. wt. approx. 1100 lbs.)	*Fattening calves in dry lot, generally in winter (weighing 400 to 500 lbs. start of feeding and 650-750 lbs. at marketing).	Wintering yearlings; roughed through the winter, and generally pasture fattened the following summer. Fed for winter gains of 1 to 1¼ lbs. per head daily (weighing about 600 lbs. start of wintering).	Fattening yearlings in dry lot, (weighing about 600 lbs. start of feeding, and 750 to 900 lbs. at marketing).	Fattening two-year-old steers in dry lot, (weighing about 800 lbs. start of feeding and 1,000 to 1,200 lbs. at marketing).
	lbs. per day	lbs. per day	lbs. per day	lbs. per day	lbs. per day
1. Legume hay or grass-legume mixed hay, good quality......	18-28	5-6	16-24	6-8	8-12
Grain......................	—	10-12	—	12-18	14-18
2. Grass hay or other non-legume dry roughage................	18-28	4-5	16-24	6-8	8-12
Grain......................	—	8-12	—	11-16	12-16
Protein supplement..........	½-1	1¾-2	1½-1¾	1¼-1½	1½-1¾
3. Silage......................	40-45	6-8	40-50	12-18	16-24
Legume hay or grass-legume mixed hay, good quality......	5-6	2-3	2-4	2-3	3-4
Grain......................	—	6-10	—	11-16	12-16
Protein supplement..........	—	1¾-2	¾-1	¾-1	¼-½
4. Silage......................	40-45	6-8	40-50	12-18	16-24
Grass hay or other non-legume dry roughage................	5-6	2-3	2-4	2-3	3-4
Grain......................	—	6-10	—	11-16	12-16
Protein supplement..........	½-¾	2-2¼	1¼-1½	1-1¼	1-1¼

*In general, the experienced feeder plans that cattle on full feed shall receive about 1½ to 2 pounds of grain for each 100 pounds of live weight. In areas where roughage is more abundant and comparatively cheaper than grain, the proportions of roughage to grain should be somewhat higher than indicated. In computing roughage consumption, three pounds of silage are considered equivalent to one pound of hay.

MANAGEMENT OF THE BEEF HERD

Economy is an Absolute Necessity

In order to keep costs down to the minimum, the beef breeding herd must be maintained on roughage and pasture, with the latter providing the feed requirements for at least six months of the year. Roughage is of equal importance during the winter feeding period. If it becomes necessary to feed grain, except during the period immediately previous to calving, the operator has too many cows.

Breeding animals must not be allowed to get too fat nor should they be permitted to get into a thin, run-down condition. During the grazing season, good luxuriant pasture is the best and most economical conditioner—it supplies all the essential nutrients at a low cost. Furthermore, grazing gives the cows an opportunity to get exercise and sunshine, both of which are beneficial to their health.

Since over-stocking invariably results in thin cows, stunted calves and impaired pasture, it is advisable to maintain only the number of cows that can live well on the pasture which can be spared for them. On the other hand, if the pastures become short as a result of a prolonged period of drought, a supplemental feed such as silage, green forage crops or grain should be provided.

Since costs are highest during the winter feeding period, good management is of primary importance then. Silage, low-grade hay and straw can be utilized in the rations of the cows if there is a variation in the quality of roughage; thus, most of the grain and the better roughages can be reserved for the growing young stock and the cattle that are being fattened.

Most producers estimate that three tons of silage and one ton of hay will carry a cow through the winter months. If the hay does not contain some legumes, a protein-rich feed should be fed toward the end of the gestation period. Of course, water should be available to the cows at all times.

All cattle need salt, and the cobalt-iodized product is recommended. As a general rule, it pays to self-feed a simple mineral mixture as an insurance against any possible lack of mineral in the ration.

Beef cattle should not be fed for any long period of time on a ration that does not contain some green, leafy roughage; they are liable to suffer from vitamin A deficiency. Cows that are wintered on wheat straw, corn stalks and other low-grade roughages which are deficient in vitamin A often produce weak calves. Vitamin D, which is also required by beef cattle, is supplied under normal conditions by direct sunlight and by feeding sun-cured hay.

When grain is fed to dry cows during the winter months, the percentage calf crop is not increased, nor is the vigour of the individual calves improved to any appreciable extent. However, grain-fed cows are usually fatter and they may milk a little better in the spring before going on grass. Even so, the cost per calf is invariably greater when grain is fed to the cows.

When formulating rations for a breeding herd, the following considerations should be borne in mind:

(a) Cattle which are being fed good corn silage are also receiving some corn.

(b) Well cured mixed hay usually provides the necessary amounts of protein and vitamins, as well as a portion of the mineral requirements.

(c) Green coloured roughages supply vitamins.

(d) Good fall pasture helps to condition the herd for economical wintering.

Care of the Cow at Calving Time

The gestation period of a cow is 283 days but this period may vary a few days. The prudent herdsman must be prepared to take care of his animals at calving time.

During the last few days of the gestation period, certain changes occur in the pregnant animal which signify that parturition is near. Some of these are: a noticeable enlargement of the udder and a change in the contents of the udder from a watery secretion to a thick, milky colostrum; a relaxation or falling away of the muscular parts in the region of the tail head and pin bones; and an enlargement and thickening of the lips of the vulva which cause them to appear swollen and somewhat inflamed.

The immediate indications of calving are: separation from the rest of the herd, nervousness or uneasiness, and muscular exertion and distress. When the weather is warm, the most natural and the most sanitary place for the cow to calve is a clean pasture away from other live stock. If the weather is inclement, a roomy box stall or maternity pen which has been carefully cleaned, disinfected and well bedded should be provided.

A good rule to follow at time of parturition is to be near but not in sight. If presentation is normal, no assistance will be required. On the other hand, when a cow has laboured for two or three hours, without results, she should be examined by an experienced herdsman or veterinarian and given assistance, if necessary. After calving, further attention is seldom necessary, since most cows can usually take care of their new-born calves.

When calves are born out on clean pasture or in sanitary quarters, there is little probability of infection entering through the navel cord. Treating with tincture of iodine lessens the danger.

Under normal conditions, the placenta or afterbirth should be expelled in from three to six hours after calving. When it is retained for twenty-four hours, prompt attention should be given by an experienced herdsman or veterinarian.

If a cow calves on good pasture, no supplementary feed will be necessary. When calving takes place inside, she should be given laxative feeds, such as wheat bran with a few oats, and all the hay she can consume for the first few days, and then gradually returned to her normal feed. The amount of feed given should be governed by the milk flow, condition of the udder, demands of the calf, and the appetite and condition of the cow. Water should be given at frequent intervals during the first few days. If the weather is cold, it is advisable to warm the water to remove the chill.

Age to Breed Heifers

As a general rule, heifers start coming in heat soon after they are one year old and will continue to come in heat approximately every twenty-one days until conception takes place. The age to breed depends on her growth and development. If a heifer is well grown, it is a safe rule to breed her at the first heat period after she is eighteen months old; thus, she will be about twenty-seven months of age at calving time.

Inasmuch as it is desirable to have all members of the herd calve within a short period of time, it is not always possible to arrange a breeding program which will provide for all heifers to calve at this age. If it is observed that the first pregnancy and lactation period have served to check a heifer's growth, she should be rested for two or three months longer than normal before being rebred. When given proper care, she will remain a regular breeder until ten or twelve years old, and in some cases, even longer.

Breeding Season and Time of Calving

The season at which cows are bred depends upon available housing facilities, feed supplies, labour, and whether the herd is a commercial or purebred one.

The commercial producer must decide whether he is going to breed for spring or fall calves. If breeding is confined to one of these seasons, all the calves will arrive within a short space of time, nine to nine and one-half months later. This procedure ensures having a more uniform group of calves to sell or enter the feed lot.

Advantages of Spring Calves

1. Dry cows can be wintered more cheaply because of the greater use of roughage.
2. Cows and calves can run on pasture; thus, less labour will be required.
3. Cows are bred while on pasture, and hence are more likely to conceive.
4. If the calves are sold at weaning time, no wintering is required; if sold as yearlings, only one wintering is necessary.

Advantages of Fall Calves

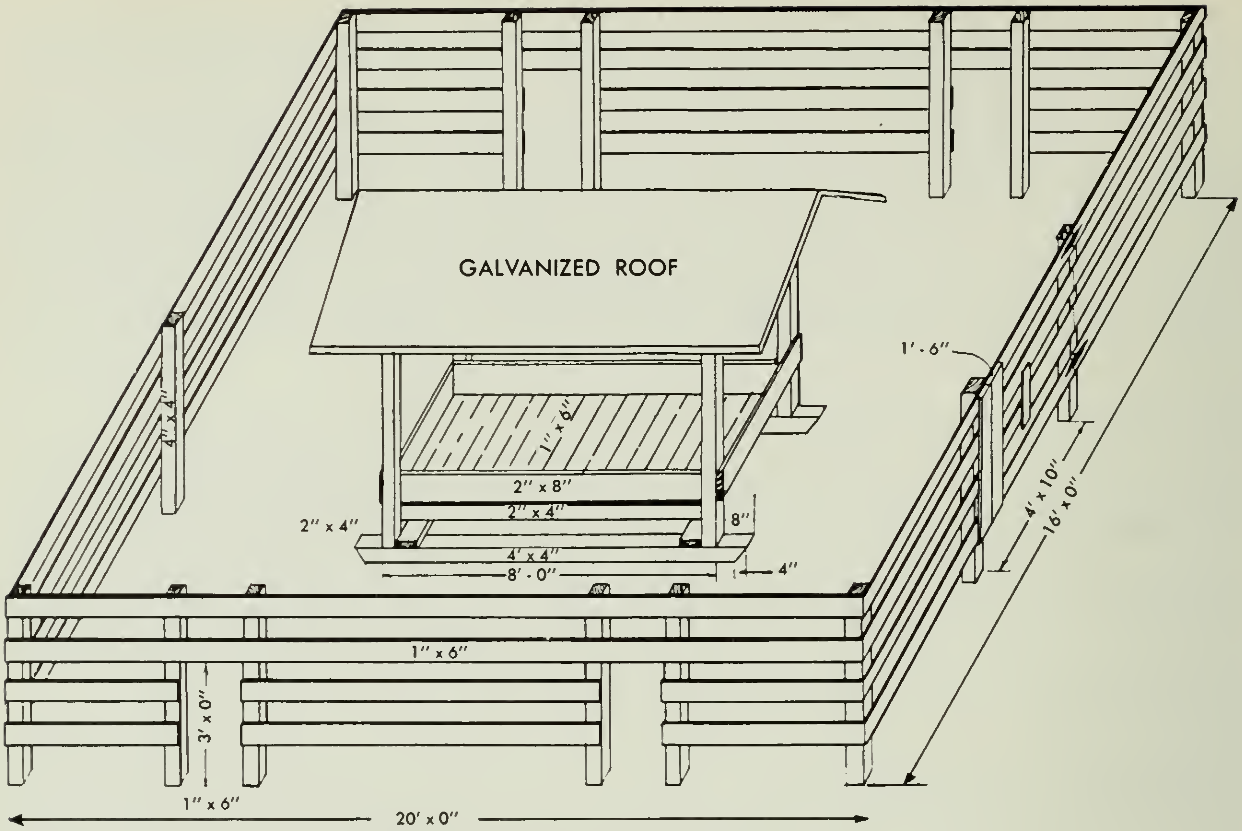
1. Cows are in better physical condition for calving after having been on pasture during the summer.
2. Calves escape the heat and flies of summer.
3. The greatest number of cattle are on hand during the winter season when labour is available for their care.

Castrating and Dehorning

All bull calves, except the purebreds which are being retained for breeding purposes, should be castrated—preferably when from three to four weeks old. Any calves that are to be fattened should be dehorned. This operation can be performed when the calves are a few days old by the use of caustic potash. The procedure involves washing the soft horn button and then rubbing it with a stick of caustic potash until its surface has become red and moist. Usually one treatment is sufficient to destroy the horn.

Electric dehorners can also be used. Best results are obtained when the dehorner is used as soon as the horn button is prominent enough to be easily located. To avoid horn stubs, caustic potash or electric dehorners must be used properly.

Cattlemen with large herds prefer to dehorn their calves in the fall, at which time special "keystone" dehorners or scoop type dehorners can be used.



Creep feeder for calves

Unless the operator of a keystone type dehorner is extremely careful, short, unsightly stubs of horns are likely to remain. Cattle on which a scoop type dehorner has been used acquire characteristics about their heads closely resembling those of natural polls.

Regardless of the method used, dehorned cattle are popular with buyers of feeder cattle and of fat cattle alike. The feeder buyer prefers them because of their tendency to settle down and feed; the buyer of market cattle because their carcasses are less likely to be damaged by bruising.

Creep-Feeding Calves

When beef calves are allowed to remain with their mothers on pasture throughout the grazing season, creep-feeding is commonly practised during the latter half of the nursing period. This is accomplished by building a small enclosure, preferably near the watering place. The enclosure should have openings just large enough for the calves to get through and should be equipped with a trough or self-feeder for grain. Calves soon learn the purpose of the creep and will enter it to feed whenever their mothers come to the water tank. Almost any mixture of ground grains, such as one-half barley and one-half oats, or a mixture of corn, wheat and oats, or of wheat, barley and oats, will be satisfactory. Since the calf gets some protein from the milk of the mother and some from the grass, a protein supplement is not essential in the ration that is fed in the creep. Usually, the creep-fed calf will weigh from seventy-five to one hundred pounds more at weaning time than the calf raised without this extra feed. Since each calf will consume approximately 300 pounds of grain during the creep-feeding period, the extra growth made at that time represents the cheapest gain made in preparing the animal for market.

Raising Beef Calves on Skim Milk

Many beef producers in Ontario are also cream producers. The cows are milked, the milk is separated, and the skim milk is used for feeding. It can be utilized to advantage in the raising of beef calves provided that it is supplemented by other feeds. Even so, calves should nurse their dams for three or four days, and then be placed on a diet of whole milk until three weeks of age, at which time the switch from whole to skim milk should commence.

The following feeding schedule is recommended:

Age of Calf	Whole Milk	Skim Milk	Grain Mixture*	Hay	Mineral
1-3 days	(Lbs. Daily) With dam or milk from dam	(Lbs. Daily)			
3-14 days	8-10	None	None	None	None
3rd week	11-15	0-6	Small amount in pail	All will eat	Cattle mineral mixture. All will eat.
4th week	5-0	6-12	About ¼ lb.		
5th and 6th week		12-14	Increase slowly to ¾ lb.		
7th to 20th week		14-16	¾ to 3 lbs.		

*See mixtures, page 25.

Feeding after Weaning

In baby beef production, it is assumed that the calf will be started on the fattening ration shortly after weaning. Creep-fed calves and skim milk-fed calves should be continued on grain following weaning; otherwise, much of their calf fat will be lost and more time will be required to prepare them for market. The change-over to a heavier fattening ration should be gradual. A fattening period of seven to nine months is normal to finish baby beef calves properly. During this period, at least fifty per cent of the roughage should be legume hay.

As a general rule, range-raised calves have not been creep-fed. If purchased at weaning time for finishing as baby beef, they should be started on a small amount of a light, bulky grain ration and gradually worked up to a full feed of grain in about a month.

Winter Management of Young Breeding Animals

During the winter months, the young heifers which are intended for breeding purposes should be given careful attention. Since size and all-round development are very important in breeding animals, feeding should be designed to promote maximum growth.

It is advisable to separate the heifers from the breeding herd. They should have access to yards or fields for exercising, and to sheds or barns for protection during inclement weather.

No feed other than high quality roughage and silage will be necessary if the heifers go into winter quarters in good condition. If the roughage is of low quality, three to five pounds of grain per day should be fed in addition. Corn, barley and oats, plus a protein supplement such as linseed oilmeal or soybean oilmeal, are quite suitable for use in the preparation of the grain mixture.

Care and Management of the Bull

Exercise throughout the year is one of the main essentials in keeping the bull in a thrifty condition. During the summer months, one of the best and easiest ways of providing exercise is to turn the bull into a two-acre paddock with an inexpensive portable shelter adjoining. If possible, the paddock area should be well turfed with succulent grass, since this is an ideal feed for a breeding bull. When these facilities are not available, he should be stabled in a box stall in the barn, both summer and winter, but turned into the paddock for several hours each day.

The feeding program should be designed to keep the bull in a thrifty condition—neither too fat nor too thin. Home-grown grains and roughages should be fed but, if the latter are not legumes, some protein-rich feed must be added to the home-grown grains.

The amount of feed will depend upon the time of the year. Throughout the grazing season, the mature bull will require little or no feed other than good pasture but, during the winter months and the heavy breeding season, he will probably require some grain in addition to roughage.

Systems of Mating

There are two systems of natural breeding, namely, hand mating and pasture mating.

In hand mating, the bull is kept away from the cows at all times except when a cow is to be bred. As a general rule, only one service is permitted during the heat period. By this method, a large number of cows can be served by one bull and an accurate record can be kept with regard to his performance in settling cows.

In pasture mating, the bull is turned in with the herd at the beginning of the breeding season and allowed to run with the cows. With this system, less labour is required and there is less chance of missing the cows during the heat period; nevertheless, the cows must be watched in order to determine whether they are being settled.

Number of Cows per Bull

A bull should be at least fifteen months old and well grown before being used, and then only on from ten to fifteen cows. For pasture breeding a bull should be at least two years old. If a younger bull must be used, he should be kept away from the herd, given special care and permitted to serve the cows as they appear in heat. When hand mating is practised, a two-year-old bull may be used on from thirty to thirty-five cows, and a three-year-old on from forty to fifty cows during the breeding season. If pasture mating is practised, these numbers should be reduced.

Success in beef production depends to no small extent upon the type and merit of the sire and on the percentage calf-crop secured each year. Paying more attention to getting cows in calf will help to increase profits.

Identification of Progeny

A live stock production program is not complete unless ways and means are taken to identify and record the progeny of the herd. Calves can be identified by brand, tattoo, ear mark or neck chains. An identification is necessary; otherwise, it is almost impossible to maintain records on the cows from the standpoint of their regularity in breeding and of the progeny with respect to their performance in the feed lot, particularly their weight for age, rate of gain and value on the market. This information is valuable when it comes to the selection of the stock for replacement purposes.

Production of Fat Cattle for Market

Each year, steers and heifers which vary in age, degree of thrift, growth for age and amount of finish are offered for sale. Usually, a profit can be made in fattening any of them if they are bought at the right price and if their grade status is improved as a result of feeding. In most instances, steers of the better grades prove to be the best investment, particularly if the purchaser intends to full feed grain for a long period and to produce a high degree of finish.

Although cattle may be purchased on a per head basis, it is usually advisable to buy by weight. Weight estimates may be influenced by the time of day, the cloudiness of the day, irregularities of the ground, distance from the cattle indoors or outdoors, the amount of bedding or mud in the yard or on the animals, and the warmth of the animals.

Each class or grade of cattle must be fed differently if maximum profits are to be made. For example, older cattle fatten more quickly than younger ones. They also make greater daily gains but require more feed per hundred pounds of gain. Other cattle have acquired their growth, and hence put on fat when placed in the feed-lot. Young cattle make their gains through growth and finish. Heifers do not grow as rapidly as steers; usually, their market value is lower.

Fattening Cattle

The object of fattening cattle is twofold: to bring the greatest return to the feeder on his home-grown feeds and to improve the quality of the meat by making it better flavoured, juicier and more tender.

In a general way, there are three practices followed in fattening cattle for market: baby beef production, feed-lot fattening and pasture fattening.

1. Baby Beef Production

During recent years, many beef cattle producers have been feeding their cattle with a view to marketing them at younger ages because of the consumer demand for smaller and lighter cuts of beef. There are two sources of cattle for this type of feeding, namely, calves produced by the home herd and calves offered for sale either on the market or on the range.

If one decides to engage in light-weight beef production, the calves should be put on full feed as rapidly and safely as possible, and carried through on all the grain they can consume until they are ready for market. In baby beef production, a specialized product is being produced; hence, the following requirements are essential to success:

(a) The calves should be well bred—scrubs or plain calves will not develop or fatten to make high quality beef regardless of how they are fed.

(b) Heifers can be used in baby beef production provided they are marketed before they become patchy and wasteful.

(c) Concentrates, both grain and protein feeds, must be fed liberally and nothing but the highest quality should be used.

(d) Calves have only a limited capacity for roughage; hence, the roughage which is used should be of the highest quality.

(e) If range calves are being fed, careful handling is necessary to avoid severe loss at the time of transfer. Such calves should be started on feed carefully, and yet should be on full feed as quickly as possible. Usually they will not be ready to market at as early an age as home-grown calves.

2. Stable or Feed-Lot Fattening

This method is followed to a considerable extent by persons who purchase feeder cattle which have been produced on the range or in the feeder-cattle-producing areas of the East. The cattle are placed in the stable or the feed-lot and gradually they are put on fattening feeds until the desired finish is obtained. The length of the feeding period will depend on the weight at the time of purchase and also upon the grade of beef desired.

Since cattle fattening is now an established practice in many parts of Ontario, it would appear that several feeds (including by-products), many methods of preparation and numerous combinations of feeds can be used successfully and profitably. What feeds to use, how to prepare them, how to mix them and what quantities to feed must be determined for each group of cattle. If home-grown grains are to be fed, the farmer can simplify the problem by growing those that can be produced most economically on his own farm.

Feed makes up about eighty per cent of the cost of fattening cattle. Most of the feed used is forage and grain which can be raised on the farm. Home-grown feed is usually the best and cheapest. The best feed for beef cattle is grown on fertile land. Hay and grain grown on rich land are preferred by cattle and are worth more per ton or per bushel than feed grown on poor land. Roughage is the basis of the ration for winter feeding.

3. Pasture Fattening

This system is used where moderately priced grazing land is available. Cattle finished on grass may not make gains as rapidly or finish to as high a degree as cattle fattened on grain; moreover, they do not bring as high a selling price as grain-finished animals. However, when grass is plentiful and cheap, one can usually afford to sacrifice in gain, finish and selling price because of the much lower cost of production. Pasture is a basic feed and the key to economical production of beef on grass is pounds of beef produced per acre.

Where pasture fattening is followed, any one of the following systems may be used:

(a) The use of pasture alone—no concentrates being fed.

(b) The use of pasture, plus a limited grain ration during the latter part of the grazing season. This practice can be recommended because of the fact that cattle make from 50 to 60 per cent of their gains during the first two months of the grazing season. If the gains slow down, grain feeding may be warranted provided there is a fair relationship between the price of grain and the price of cattle. Furthermore, grain feeding during the latter part of the grazing season improves quality and increases yields.

(c) The use of pasture, plus a full grain ration until cattle are marketed. This practice depends upon the weight and condition of the cattle, the kind of pasture and whether or not it is desired to have cattle ready for market at an early date. Well-wintered, fleshy cattle finished in this way will eat less grass and more grain. Market values must again be taken into consideration. Big, thin steers will make very satisfactory gains on pasture alone. Barley, corn or a mixture of feeds cannot compete with pasture in putting gains on thin steers. Fleshy steers taken off pasture will gain and fatten quite rapidly when put on a full feed of grain.

The choice of systems to follow will depend upon the age and condition of the cattle, quality of the pasture, price of grains and concentrates, and the market price of cattle.

Selecting Feeders

The age and class of cattle one should purchase will depend upon: (a) the amount of feed on hand, (b) the price of feeds that it may be necessary to buy, and (c) the length of time the cattle are to be fed.

Ability to gain and efficiency in the use of feed are inherited to a considerable degree. Hence, the performance of cattle that appear similar in type may vary quite widely. In general, deep, rugged-boned cattle eat more, gain faster and make more efficient use of feed than fine-boned, compressed-type cattle of the same age.

The following facts should be kept in mind in selecting feeder cattle:

(a) Plain or poorly-bred cattle, if deep, thrifty and not stunted, may gain almost as well as better-bred ones, especially if the feeding period is relatively short. However, they may not be as uniform or smooth in finish when ready for the market.

(b) When cattle of the same type and breed are fed to about the same degree of finish, calves will use feed more efficiently than older animals. On the other hand, older animals can utilize coarse feeds such as corn stalks or hay to better advantage than calves.

(c) Older, thin cattle make the greatest gains per head and improve in condition at the most rapid rate; yearlings rank second and calves third in this regard. However, on the basis of gains per 1,000 pounds of starting weight or per acre on grass, calves rank first, yearlings second and two-year-olds third.

(d) Relatively thin cattle make the greatest gains and best use of grass regardless of weight. Cattle that have been wintered well and, as a result, are carrying a fair amount of finish will be ready for market at an earlier date if fed grain while on grass.

(e) Cattle weighing between 800 and 900 pounds which have been wintered on low-grade roughage will become fatter on good grass alone than will either yearlings or calves. Hence, when the price level is high, it is advisable to purchase stocker cattle that are not too far forward in finish.

(f) Spayed heifers make slightly better gains than open heifers after they have recovered from the effects of the operation; however, the difference is not sufficient to compensate for weight lost or for the expense and risk involved.

(g) Health is important, especially with calves or young cattle. It is always wise to be on the lookout for stale, out-of-condition cattle or for those that do not appear to be healthy.

Feeding a Protein Supplement

If a protein supplement is to be fed, it may be added to the grain mixture any time after the first week of feeding. Any of the standard protein supplements such as linseed oilmeal, soybean oilmeal or cottonseed meal are quite satisfactory. At the outset, the quantity fed should not exceed one-half pound per head per day, but this amount may be increased gradually over the next five to six weeks. Unfortunately, there is no simple rule for determining the amount that should be fed for economical feeding; it may vary from none to as much as two pounds per head per day, depending upon the age of the cattle, the quality of the roughage and the cost of the protein supplements by comparison with that of the other ingredients in the ration. Usually, one and one half pounds per head per day will suffice to balance the ration.

Inasmuch as calves and yearlings are still very much in the growing stage, their protein requirement is greater than that of older cattle. Furthermore, protein supplements are more essential when a bulky ration, which includes silage, is being fed than when the ration is heavier. Finally, protein supplements are almost a must when non-legume hay is being fed. As a general rule, it will be good economy to use a protein supplement when grain prices are high because the supplement will cost less in relation to its nutritive value. When supplements are comparatively low in price, they should be fed liberally to fattening cattle.

Self Feeding vs. Hand Feeding

The use of self feeders in fattening cattle can be recommended especially in the case of cattle that are fed for a short period of time before being marketed. However, this method is not recommended for cattle which are to be fed for an extended period and which, as is usual in such cases, are not being fed a full feed of grain.

The principal advantages of self feeders are as follows:

(a) They contribute to a saving of time and labour;

(b) Cattle make greater daily gains;

(c) Cattle are less likely to go off feed.

Of these advantages, the saving of labour is by far the most important. Large quantities of feed can be prepared and placed directly into the feeders with a minimum of time and labour. Hand feeding, on the other hand, may require the preparation of each feed at the time that it is fed or the re-handling of the material in the case of feed prepared in quantity and stored;

The principal disadvantages of self feeders are as follows:

(a) It is impossible to utilize large amounts of farm-grown roughages because cattle that are given free choice of grain will not eat so much roughage;

(b) A larger investment in equipment is required;

(c) There is a slight increase in the cost of the gains made.

Self feeders are somewhat more expensive to build than ordinary troughs and bunks. Since it is necessary to construct bunks for the feeding of silage, the cost of building both bunks and self feeders represents an added cost.

Group vs. Stall Feeding

Cattle are influenced by what their companions do; each has a strong desire to enter into the activities of the others. No sooner does one steer get up from his bed and walk to the feed trough than the others lying nearby begin to follow his example. As a result, it is generally conceded that cattle fed together will eat considerably more than cattle fed separately. The same holds true in the pasture field.

PASTURE

PASTURE BASIC TO ECONOMICAL BEEF PRODUCTION

Tests conducted under the Advanced Registry Policy for Beef Cattle indicate that beef steers on full feed consume approximately six pounds of grain mixture for every pound of gain. If grain were the only feed utilized in their production, beef cattle would have the doubtful distinction of being the least efficient of all meat animals from the standpoint of converting raw materials into meat. However, this deduction is made without due consideration of the fact that beef cattle have a tremendous capacity for consuming roughage and that high-quality roughage will produce growth, gain in weight and finish.

If beef production costs are to be reduced to the point where producers can compete successfully with their competitors in the hog and poultry businesses, full advantage must be taken of the steer's ability to convert roughage into meat. Grass is the best roughage produced in Ontario. It can be used as pasture, as hay and as silage. It provides feed in its least costly form when used as pasture because no handling or storage charges are incurred.

SOIL FERTILITY DEPLETED BY CONSTANT GRAZING

When pastures are grazed year after year, the stand of grass becomes thin and weeds threaten to supplant all that remains except the hardy, native species. This trend can usually be attributed to a gradual but certain reduction in the fertility level of the soil. A 1000-pound steer contains the equivalent of about 16 pounds of phosphoric acid (P_2O_5), 23 pounds of nitrogen (N) and 2 pounds of potassium (K_2O). The amount removed per acre will depend upon the number of pounds of beef produced on each acre. In any event, the quantity of essential elements replaced by the droppings is insignificant by comparison with the amount removed.

ESSENTIALS OF A GOOD PASTURE

A good pasture is one that provides an abundant and continuous feed supply for at least six months of the year. Grasses and clovers will grow fairly rapidly during May and June when the temperature is moderate and the rainfall is adequate. However, their rate of growth slackens quite sharply with the arrival of the hot, dry weather associated with July and August. During this period, the plants become dry and woody, and hence are less palatable and nutritious. A rejuvenation invariably takes place in September when the weather cools off and rains become more frequent.

As a result, cattle produce over sixty per cent of their total gains during the first eight to ten weeks of the pasture season. Quite frequently in July and August, gains are nil and sometimes cattle actually lose weight.

The problem of providing an abundance of green feed during the hot weather is not easily solved. Nevertheless, the adoption of certain recommended practices of pasture improvement and management will facilitate the achievement of that objective.

METHODS OF PASTURE IMPROVEMENT

There are two standard methods of pasture improvement: (a) top dressing

A group of steers on good grass-legume pasture

permanent grassland areas with manure or commercial fertilizer or both, and (b) breaking up old sod and reseeding after a seed bed has been well prepared and fertilizer has been applied in accordance with the needs of the soil.

The initial cost of pasture improvement is less when the first named method is used. However, money expended in pasture improvement should be considered an investment rather than an expense. Viewed from that standpoint, the more costly method may prove to be the wiser investment.

The practice of fertilizing old sod has definite possibilities under certain circumstances. It offers the only practical method of increasing grass production on land that is too rough to be broken up and tilled by modern machinery. Furthermore, it will probably prove to be the more economical method of improving the herbage on tillable land, provided that there is a reasonably good stand of useful plants. On the other hand, when the stand of herbage on tillable land is thin, it is advisable to break it up and re-seed.

ESTABLISHING A PERMANENT PASTURE

While certain methods of surface cultivation appear to have possibilities, it is usually advisable to break up an old sod by plowing—preferably in the fall. If done then, the land may be seeded the following spring. However, it is considered good practice to produce a grain or corn crop in the first year and thus more time is allowed for the old sod to become thoroughly rotted and, at the same time, there is a cash income to help cover the cost of breaking up and re-seeding.

Regardless of the practice followed, particular care must be taken in the preparation of the seed bed. The land should be well worked and packed until it is firm but not hard. Opinion varies with regard to the advisability of seeding with a nurse crop. Usually, a better "catch" is obtained in the absence of one. However, a nurse crop such as oats will provide protective shade to the young seedlings and a substantial amount of feed during a critical time in the pasture season.

When oats are used as a nurse crop, the rate of seeding should not exceed one bushel per acre. If the oats are intended for pasture, the cattle should be turned in when the oats are coming out in head in sufficient numbers to graze the crop in a three-week period. If, during the process of grazing, the cattle start pulling up the young seedlings, they should be removed at once; otherwise, permanent damage to the grass may result.

As a general rule, May is the best month for seeding down permanent pastures. However, grasses may be sown in the fall—preferably September. If so, the clovers are sown in the early part of the following spring.

In many instances, failure to obtain a satisfactory "catch" can be attributed to the fact that the seed was sown too deeply. The seed should be deposited at a depth of less than one inch below the surface of the ground. In order to achieve this objective, it is advisable to sow the nurse crop and the fertilizer at the regular depth, and then cultipack or roll the field. The grass-legume mixture may be seeded by use of a grass seed attachment on a grain drill, a cyclone seeder or one of the newer grass seeding implements. Brome grass seed presents a problem as it will not pass through the grass seed attachment of grain drills. The problem may be solved by mixing with the nurse crop and sowing through the grain spouts. It may also be seeded with a cyclone seeder before the other seeds are planted, in which case the seed will be covered by the planting operation. The newer seeding implements have separate compartments for seeds of various sizes and attachments to ensure an even deposition of the seeds.

In seeding, three operations are of primary importance: (a) the land must be well worked so that a fine seed bed results; (b) the land must be packed with a cultipacker or roller to remove any semblance of looseness; and (c) the seed must be deposited in the ground at a depth of from one-half to one inch.

SEED MIXTURES

A seed mixture should contain a variety of clovers and grasses—preferably grasses that reach maturity at different times of the season, thus avoiding dry and woody material during the critical period of the pasture season. If the pasture is overstocked, the cattle may eat the crowns of the plants, thus thinning the stand.

Mixtures which have proven satisfactory on various types of land are as follows:

(a) Long term pasture mixture for well drained clay loam and heavy clay soils of average fertility:

	Pounds per Acre
Alfalfa	6
Ladino Clover	1
White Dutch Clover	1
Timothy	2
Brome Grass	7
Orchard Grass	3
Meadow Fescue	2
Total	22

Where unusually dry conditions prevail, the Ladino clover is replaced with White Dutch clover.

(b) Long term pasture mixture for light, sandy or gravelly soils:

	Pounds per Acre
Alfalfa	3
White Dutch Clover	1
Sweet Clover	4
Timothy	5
Brome Grass	5
Orchard Grass	4
Red Fescue	2
Canadian Blue Grass	3
Total	27

(c) Long term pasture mixture for low-lying, poorly-drained soils subject to flooding:

	Pounds per Acre
Empire Birdsfoot Trefoil	5
Alsike	2
White Dutch Clover	1
Reed Canary Grass	6
Meadow Fescue	3
Red Top	1
Total	18

Inasmuch as some of the grasses in these mixtures are interchangeable, the quantities suggested may be altered slightly, depending on the price of the seeds, without reducing the value of the mixture from a pasture standpoint.

FERTILIZER REQUIREMENTS

Since reseeding is a fairly costly operation, it is poor economy to break up land and seed it with expensive seeds unless one is prepared to give those seeds every possible opportunity of developing into strong, healthy plants. As a general rule, land that has been in pasture for a long period of time is in a low state of fertility, and hence requires plant food. A soil test will disclose the elements which are lacking; so, the information obtained as a result of such tests should provide the basis for decisions with regard to fertilizer purchases. Particulars regarding the taking of soil samples and the procedure to be followed in having tests made may be obtained from county agricultural representatives. An application of any standard fertilizer at the time of seeding may protect the investment in seeds, but an application of a fertilizer containing a preponderance of those elements which are lacking may not only protect the investment in seeds but might also result in a considerable saving in the cost of fertilizer.

Where the soil test has not been applied, it is usually advisable to use a complete fertilizer such as 2-12-6, 4-12-6 or 3-18-9 at the time of seeding. Clovers and alfalfa are quite responsive to phosphates and potash. Since these plants extract nitrogen from the air and deposit that portion which is not utilized in their growth in the soil, this element may not be needed in subsequent fertilizer applications.

As a general rule, applications at the time of seeding should be at the rate of from 300 to 350 pounds per acre. Thereafter, best results are likely to be obtained if the phosphates and potash are applied in the fall and if nitrogen is applied in the spring. Midsummer applications of nitrogen are effective if followed by sufficient moisture to cause it to dissolve, thereby making it available to the root system.

The frequency with which fertilizer is applied will depend upon the level of fertility in the soil. In most soils, the influence of fertilizer is projected over a period of at least two or three years. This general rule will not apply in the case of loose, open soils which are characterized by leaching. Except where the latter conditions prevail, the cost of maintaining soil fertility is less when a fertilizer is applied according to requirements in fairly generous quantities at three-year intervals rather than under a system of applying lesser quantities annually.

RENOVATING OLD PASTURES

The practice of renovating old pastures is of particular significance in cases where land that is too rough to plow is being used as pasture, or on plowable land that has a fair stand of grass. In either case, the herbage is likely to contain a high percentage of weeds. Such being the case, the first step in renovation is to get rid of the weeds and thus free the grass plants from this unnecessary and undesirable competition. Herbicides which are quite effective in weed control have been developed and should be used according to manufacturers' directions, particularly in areas where the topography of the land will permit the use of power sprayers.

The next step is to get more desirable plants per square foot. This can be done by broadcasting seed on the bare spots or by natural re-seeding, a condition which can be accomplished by removing all live stock from the area for one year, thereby permitting the plants to develop seed. In either case, plant food must be applied in the form of fertilizer to ensure the growth of healthier, stronger plants and to suppress the growth of weeds which will otherwise make their presence manifest.

As in the case of new seedings, plant food must be applied from time to time. Usually, these applications cause native clovers such as White Dutch or Alsike to reappear. However, these clovers will not change the species of the grasses. A renovated pasture is not as productive as one that has been reseeded; nevertheless, production can be substantially increased by renovation.

PASTURE MANAGEMENT

It is rather important that a pasture be grazed fairly early in the spring; otherwise, the tall-growing grasses are likely to tower over the bottom grasses and legumes. Nevertheless, cattle should not be allowed on pasture fields until the land has become sufficiently firm to withstand tramping. It is advisable to keep cattle off until the grass is from four to six inches tall. Except for unusually wet seasons, the ground will be reasonably firm by the time growth has progressed to this stage.

Most grasses reach maturity in early July, at which time they become less palatable and nutritious. In order to reduce the possibility of this condition developing, pastures may be clipped about the middle of June. Clipping can be done with a mower, in which case the cutting bar should be raised to a height of from six to eight inches. Thus, the main stems are clipped off and new leafy growth begins to develop.

Clipping can be recommended for two additional reasons: (a) it helps to control weeds by removing their floral parts before the seeds have a chance to develop, and (b) the tops of the plants that are clipped off help prevent the evaporation of moisture from the ground.

However, clipping incurs certain risks as well. If a prolonged period of dry weather sets in shortly after a pasture field has been clipped, the owner is likely to experience a feed shortage, that is, unless he has taken the precaution to provide against such an eventuality. Even though an unclipped pasture may not be as palatable or as nutritious as a clipped one, it will still provide a maintenance ration which is a decided improvement over no ration at all. Such being the case, it is well-nigh impossible to make a definite recommendation with respect to clipping—so much depends upon the amount of rain which falls during the period.

In order to be reasonably sure of a feed supply in July and August, the grass should be up to the knees of the cattle in June. This will be wasteful in summers when there is an abundance of rainfall. However, most sections of Ontario experience dry weather in July and August. If pastures are stripped bare in June, they will not recover until the rains commence in the fall.

Rotational grazing has proven an excellent aid in maintaining the productivity of pastures. Electric fences can be used to subdivide large pasture areas.

Pastures should not be grazed late in the fall, nor should they be grazed to the point where the grass becomes quite short. Grass requires a certain amount of top growth as reserve strength for winter and spring.

Top dressing in the fall with barnyard manure or fertilizer will provide plant food for the following year or years. Many farmers hesitate to apply manure to pasture, believing that it can be used to better advantage with other crops. However, pasture is, or should be, the most valuable crop on a farm where beef cattle provide the major source of income; therefore, fertilizing should be considered.

In any event, the droppings from the cattle should be spread at least once every year. This can be done with a drag harrow without incurring the risk of damaging the turf. This operation spreads the droppings evenly over the field and also improves the uniformity and palatability of the pasture herbage.

EMERGENCY PASTURES

When hay-pasture programs are well planned and when pastures are not grazed beyond their capacity, it is seldom necessary to consider emergency pastures. However, seedings may be winter-killed and consideration must be given to emergency pasture crops. Satisfactory ones are:

1. **Oats.** Oats, sown at the rate of two to three bushels per acre at the regular time or a little later, will provide excellent pasture in late July and early August. Steers grazing on oats frequently make gains of two to two and one-half pounds per day. Oats may be sown in late August for fall pasture.

2. **Sudan grass.** Sudan grass may be sown about June 1st. for late July and August pasture. Seeding is usually at the rate of thirty pounds per acre. This crop should not be pastured after it has been frozen because of the danger to live stock on account of prussic acid poisoning.

3. **Rape.** Rape may be sown either in drills or broadcast—usually in early July. It may be pastured or cut and hauled to the live stock. Being fairly resistant to frost, it provides excellent high protein feed late in the fall—often right up until Christmas. Occasionally, cattle which have been pastured on frozen rape will develop bloat.

4. **Grass Silage.** The advent of horizontal silos has opened up the possibilities of conserving grass which might otherwise go to waste. Grass that is in surplus supply in June can be stored in a silo constructed in the pasture area. If there is adequate rainfall, the aftermath will provide for the cattle's requirements but, if dry weather sets in, they can be self-fed from the silo. Since silage will keep for several years, it shows promise of being not only a valuable source of feed, but a very important emergency pasture crop, particularly when stored in a horizontal silo located within close range of the pasture field.

HOUSING AND EQUIPMENT

The prime requisite of housing structures for beef cattle is to afford protection to the animals during severe cold and stormy weather and to the cows at calving time during winter months. In addition, they should provide a reasonably dry bed for the animals, storage for feed and bedding, and should be of such a plan as to conserve the fertilizing value of the manure. They should also simplify the problems of feeding and managing the stock.

In designing structures for beef cattle, one should give consideration to the entire plan of farm operations. Although the buildings may be relatively simple in construction, a high degree of flexibility is desirable in the buildings, equipment and management plans in order that adjustments may be made as new developments in agricultural practices unfold. For example, such developments as manure loaders, new methods of harvesting hay and small grains, and changes in cropping programs affect building dimensions and space requirements.

A building may be convenient, well planned and attractively proportioned without increasing its cost appreciably. Structures and equipment account for only a small part of the total cost of production. Therefore, additional building investments add relatively little to production costs and the net cost will be reduced if the investment in equipment or building layout results in saving of feed, reduction in labour or better conditions generally. Included in the list of improvements which have proved economical are: (a) shelters adapted to climatic conditions, (b) housing and feeding arrangements that save time and labour, (c) the utilization of paved feeding floors, (d) a constant supply of good water, and (e) mechanized equipment for feeding and manure removal.

The type of housing structure should be determined by the kind of stock being kept and the practices employed in its handling and management. The structures most commonly used on beef cattle farms are: (a) two-storey closed cattle barns, (b) semi-open-front type barns and (c) open-front type cattle barns.

Two-Storey Closed Barns

For breeding cattle, the two-storey closed type of barn is in most common use. A part of the interior is divided into pens for the breeding stock or is equipped with undivided tie stalls. Storage space for feed and bedding is provided on the second storey. It is the most expensive type to build because of its substantial structure and the need for a concrete floor, gutters, pens and stalls in the stable section. Nevertheless, it permits more intimate management and assessment of the stock.

In Ontario, ventilation is required in this type of barn to maintain the proper degree of humidity for cattle comfort and health, as well as suitable working conditions for the operator. Proper ventilation will prolong the life of the building.

With an exhaust fan ventilation system, a uniform condition can be maintained. The size of fan unit required is based on the number of 1,000-pound animal units multiplied by 30 cubic feet per minute in cold weather and 90 to 100 cubic feet per minute in warm weather. If a 50-cow herd is being maintained, there should be two thermostatically controlled fans operating—one continuously, the other intermittently—in accordance with requirements.

An Open-Front Barn

Semi-Open-Front Type Barns

For feeder cattle, the semi-open or the open-front type of structure is the most satisfactory. Units of this type have one or more large openings to an exercise yard on the south side or the end of the building, thus enabling the cattle to move around freely in the open-stable section or in the yard. Feed storage may be overhead, but it is usually located on the ground level in the centre section of the structure. This type of structure may be very simple in design and does not require a concrete floor or any tie stalls or pens.

Open-Front Type Barns

Where climatic conditions will permit its use, the open-front type of shelter is the most practical and the most economical for handling feeder cattle. It usually is of simple single-storey construction and entirely open to the south; nevertheless, it provides the cattle with protection from cold winds and storms. Roughage may be stored under the open-front shed and self-fed, or feed bunks may be placed along the back of the shed and the hay placed into them from a separate feed-storage unit. The depth of the barn will depend on whether it is to serve as a shelter only or if it is to combine the functions of a shelter and a feeding unit. Open-front sheds up to 50 feet in depth are being used. For widths over 36 feet, it is necessary to have posts inside the shed in order to adequately support the roof; otherwise, simple trusses which are supported by pillars at the open front, the side and the back may be used. Open-front shelters should be constructed either as single units facing south or as L-shaped units facing south and east. The length of the shed will depend upon the number of cattle to be housed. When animals have access to an outside yard, the floor area in either the semi-enclosed or open-front type shelter should be:

(a) breeding cow—40 to 50 sq. ft.
(b) yearling calf—20 to 30 sq. ft.
(c) fattening stock—25 to 50 sq. ft.
(d) bull or cow in a pen—120 to 150 sq. ft.
(e) calf in a pen—20 sq. ft.

The space required for the storing of hay will depend on whether it is baled, chopped or long, and the height to which it may be piled. Baled hay requires 175 to 200 cubic feet per ton, chopped hay 250 cubic feet per ton, and long hay 400 cubic feet per ton. Both the front opening and overhead height in the lounging section of the shelter should be a minimum of nine feet. This will permit a build-up of manure in the stabling section, thus eliminating the necessity of cleaning it out more than once during the feeding season. For permanent structures, a 3½-foot masonry type of foundation should be constructed to prevent the deterioration of walls from the manure pack.

Standard type two-storey barns may be converted into feeder cattle shelters by removing stalls and partitions in the stable section and by providing one or more large openings into an exercise yard on the south side. Unless there is at least nine feet of ceiling height, it will be necessary to clean out the barn more than once during the feeding season.

WATER REQUIREMENTS

Water is an important item in the production of beef cattle. About 12 gallons per head per day are required by mature cattle and yearlings; 7 to 8 gallons per head per day will suffice for calves. Furthermore, the water must be readily available. Outdoor tanks which are being used in winter will require insulation, covers or tank heaters to prevent freezing. In loose housing systems where water bowls are used, a system of heating by electrical coils or lamps is recommended. An electrically heated water bowl controlled by thermostat is available commercially and is also recommended if the bowl passes C.S.A. (Canadian Standards' Association) rating.

Unless a flowing supply is available, the water system should be mechanically operated and automatic. When supplied under pressure, the watering outlet in a loose housing arrangement should have a drinking area of one square foot per 25 head of cattle. A tank in a pasture field, but not on a pressure system, should have a capacity of 350 to 600 gallons, this being the minimum size recommended to provide a one-day supply for 20 to 30 head of cattle. Even so, it is desirable to construct tanks large enough to hold several days' supply of water as insurance against the possibility of power failure.

A watering tank built of concrete is sturdy; it will resist the normal abuses of the farm yard and is easily constructed. Concrete pavement around the tank maintains a clean, mud-free platform for the stock.

REMODELLING EXISTING FARM STRUCTURES

The largest percentage of improvements to farm buildings will be those concerned with the remodelling of existing farm structures and the rearranging of yards, yard equipment and feed storages. Fortunately, the majority of these old structures have sound timbers and reasonably plumb and true frames; hence, the renovating problem resolves itself into one of internal planning and possibly some foundation and roof repair.

The most common management practice involves the use of loose pens. To accommodate this system in the renovated barn, it is advisable to trim down the old structure and support it with a concrete or masonry foundation at least as high as the anticipated manure pack (approximately four feet).

Another possibility is that of utilizing the old barn as a central feed storage unit and adding wings on two or three walls to accommodate the cattle. A movable, self-feeding fence will permit the cattle to eat their way into the central storage area, thus increasing the loafing area as the season advances.

Except for the limitations imposed by location and size, it is usually possible to provide almost the same facilities in remodelled buildings as can be obtained by erecting new structures. Some of the principal problems encountered in remodelling are as follows:

(a) Relocating shelters and yards so that they will occupy a better position with respect to dwellings and other farm buildings, and to get southern and eastern exposures for the yards.

(b) Grading and draining feed-lots, and hardsurfacing feed-lots if deemed necessary.

(c) Fencing, and arranging gates and lanes to facilitate feeding and manure removal.

(d) Providing water under pressure and insulated water tanks with a paved section around the tanks.

(e) Rearranging feed storage to reduce labour in feed handling and processing.

(f) In general-purpose barns, making such changes as (i) increasing the number of openings; (ii) removing old equipment, such as horse stalls, pens and box stalls; (iii) installing hay feed racks; (iv) strengthening lofts for baled or chopped hay; (v) removing loft floor, and (vi) adding sheds, wings or extensions.

TEMPORARY WINTER SHELTERS

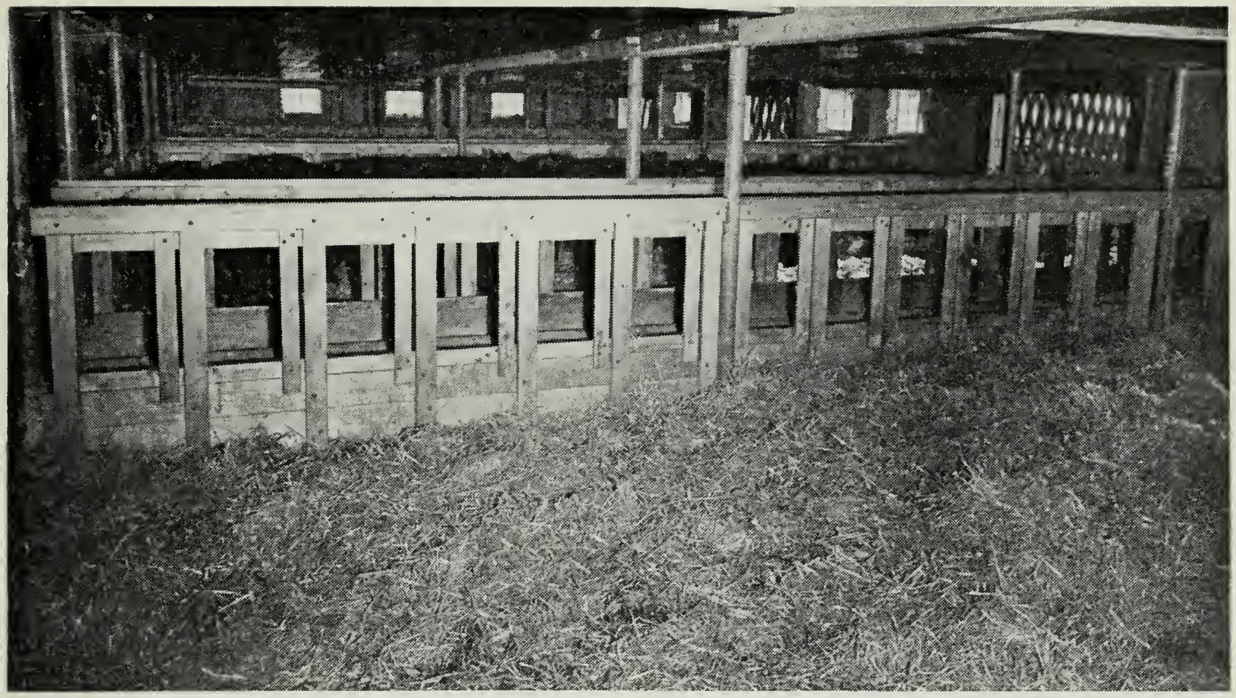
A temporary winter shelter can be constructed by using posts and straw. The posts are used to make the structure and the straw to form the covering which actually provides the shelter.

The structure must be: (a) strong and sturdy; hence, capable of supporting the weight of the straw which is used to cover it, even when the external areas of the straw are wet; (b) at least nine feet high, thus providing ample clearance between the backs of the cattle which may occupy it and the ceiling, and (c) open to the south, if possible.

The straw may be built over the structure in the form of a stack, or the two or three layers of baled straw may be placed around and over the structure. If baled straw is used, the roof area should be topped with poor quality hay to ensure run-off in rainy weather.

PERMANENT TYPE OF HAY AND SILAGE BUNKS

Permanent feeders are recommended because, once constructed, they require a minimum of maintenance. Frequently, these feeders are built along an outside wall, in which case the wall forms the back; occasionally, they are built to provide access from both sides. Although many feeders are simply vertical slats spaced about six to eight inches apart and angled out from the wall, it is



Permanent type feed bunk

advisable to provide some type of manger at the base. This manger will catch the spillage and reduce waste of roughage.

Wall type feeding bunks can be made for feeding from the inside and from the outside of the barn; construction is as described in the preceding paragraph. The outside is closed by doors hinged at the top. When opened for outside feeding, these doors protect the feed and the cattle from the weather.

Permanent-type silage bunks can be made of 2″ x 8″ planking. Four planks are used for the bottom, while one placed in a vertical position on either side forms the sides, thus making a trough 32 inches wide and 6 inches deep (inside dimensions). Sometimes trolleys are used to fill the bunks. When this is done, the inside edges of the sides are reinforced with 1½″ x 1½″ angle iron which serves as track. The bunk is supported by strong frames made of 3″ x 3″ material, securely braced. These frames are spaced ten to twelve feet apart, depending on the length of the planks. If the trolley arrangement is used, the frames should be on six-to eight-foot centres.

If silage bunks are accessible from both sides, they should be three to four feet wide. Permanent bunks can be erected either in the barn or out in the yard.

Calves eat and thrive better from bunks 24 inches high. They need about 18 lineal inches of bunk space per head. For yearlings or older cattle, bunks should be 30 inches high, with 24 to 30 lineal inches being allowed per head.

Ideal self-feeder space is 6 to 8 lineal inches for calves, 10 to 12 lineal inches for yearlings, and 14 to 18 lineal inches for large steers, although many fed cattle get along satisfactorily with as little as half that amount.

Some farmers use a combination feeding trough and shelter. If constructed to form an L with an existing structure, or by joining two buildings together, it will have the added advantage of ensuring a wind-protected yard.

A concrete feeding trough can be constructed with sides 4 inches thick, 18 inches high in front and 10 inches high in rear. The inside of the trough is 8 inches deep and 24 inches wide. The bottom should be curved with the low point toward the rear to keep the grain away from the corners and out where the animals can lick it up easily.

A concrete walk 3 feet wide behind the trough will serve as a feed alley. On the front of the trough, 2″ x 6″ dividers, 6 feet high, are placed 22 inches apart. Mid-way between each pair, shorter dividers, 3 feet high, are put in place. Two bolts embedded in the concrete base hold the dividers at the bottom. The long dividers are bolted to horizontal 2 x 6's. Seven 4″ x 6″ posts support a shed-type roof which slopes from the open front to the rear.

Feed is brought in from the adjoining barn either on pneumatic-tired vehicles or by gravity from the mow floor. A supply of feed for a week can be stored above the trough. If a silo is constructed at the outer end of the trough, an overhead carrier track will facilitate the feeding of silage.

PORTABLE BUNKS

When constructing portable bunks, one should use comparatively heavy material. The legs must be sturdy and should be constructed so that the bunk can be moved from place to place or, when placed indoors, so that it can be raised as manure accumulates. Some operators construct bunks on suspended timbers, thereby enabling them to be raised by means of pins as the feeding season progresses. In any event, the bunk must be strong enough to withstand rubbing and shoving by the cattle.

Various types of racks and mangers for feeding hay and roughage are found in common use; the type of equipment that will best fit into one feed yard might not be practical in another.

SELF-FEEDING FOR GRAIN

Properly designed and well constructed self feeders for grain are proving to be practical and safe. They can be built to handle shelled corn, corn and cob meal, or ground grain and protein mixtures.

In a self feeder, protein pellets mix and feed better with shelled corn than with meal. Self feeders are particularly popular for full feeding on pasture but they are equally practical in the feed-lot where they contribute to the saving of time and labour.

SELF-FEEDING FOR HAY

Some operators use the entire barn as a huge hay hopper. Roughage is stored in the structure and cattle eat in from the sides, either through a feeding fence of wall-type feed-racks. This type of feeding arrangement is proving very popular because a minimum amount of labour is required to continuously keep roughage in front of the cows.

A similar arrangement, but one which does not include a structure to protect the hay, is also very popular among beef producers. Roughage is stored in a stack; then, a feeding fence is erected around it. This is a very economical method of handling roughage but, unfortunately, there is a considerable amount of spoilage.

A combination of these two systems is exemplified in the Dutch-type barn with permanent feed bunks along one or both sides. Roughage is stored under the central shelter and fed into side mangers. This arrangement provides protection for roughage and is economical in that no side walls are required.

MECHANICAL FEEDING ARRANGEMENTS

Many cattlemen have mechanized their feeding programs to the extent that the push of a button engages a complicated system of motors, augers, grinders, choppers, mixers and endless belts. Within a few minutes, an entire herd of cattle may be fed without the operator lifting a shovel or carrying a handful of grain. While some operators are making this system pay for itself, others question the soundness of the plan. However, a great many operators are interested in some of the simpler arrangements which reduce labour and drudgery.

A system of feeding silage in a continuous bunk has been developed by using an endless belt or chain. This need not be endless if a return cable is anchored to the outer end. The latter is preferred since it prevents feed from building up under the belt or chain. If this system is used in conjunction with a silo unloader and grain is fed by gravity from an overhead grinding and storage space, the feeding of grain and silage can be completely mechanized.

HERD HEALTH

Without healthy cattle, no beef cattle enterprise can prosper. Fortunately, because of the more moderate demands made upon them, beef cattle are less subject to disease than are dairy cattle. Not all of the diseases which do occur are preventable and some disease loss may occur where the best of management practices are employed. On the other hand, the greater part of the disease loss suffered annually by Ontario beef producers can be prevented by the use of available knowledge.

With the exception of Foot-and-Mouth disease, the diseases discussed below represent only those which are of common occurrence among beef cattle in this Province. The description of symptoms is necessarily brief and the control measures outlined cannot cover all circumstances. They are intended only as a guide to be supplemented by further study and by consultation with your veterinarian.

TUBERCULOSIS

Great progress has been made in the elimination of tuberculosis through area testing. The Restricted Area Plan now covers all inhabited territory east of the Great Lakes and the remainder of the country is rapidly being included. Under the regulations, all areas established for the eradication of bovine tuberculosis are designated as "restricted areas". When the incidence of tuberculosis in such an area has been reduced to 0.5 per cent or less by the testing of all cattle and the slaughter of all reactors, the area is called an "accredited area". Accreditation lasts for three years, after which a retest is necessary. Individual herds may also be accredited but, in recent years, the emphasis has been placed on area testing.

Cattle purchased in areas which are not accredited or in stock yards must be tested by veterinarians of the Health of Animals Branch, Department of Agriculture. These tests may be performed in the stock yards or, in some instances, the cattle may be brought in under licence and tested at the farm. When the purchase of feeder cattle is contemplated, full information should be obtained from your nearest Sub-district Office, Health of Animals Branch, or the District Office, Health of Animals Branch, Canada Department of Agriculture, 366 Keele Street, Toronto, Ontario.

LUMP JAW (ACTINOMYCOSIS)

This infection causes the formation of hard swellings around the jaw or other parts of the head. These swellings commonly break and discharge thick, yellowish pus. Although temporary healing may take place, they will usually break out again in another spot. Occasionally, the disease may spread to the internal organs. In most instances, it does not cause serious constitutional symptoms until the swelling interferes with chewing or some other vital process.

When animals of commercial value only are affected with this disease, it is usually advisable to market them without treatment. Treatment by surgery or antibiotic injection is often successful and is justified in valuable animals. The danger of transmission from one animal to another is not great but it is always advisable to separate affected animals.

A similar infection (actinobacillosis) causes swellings in the soft structures of the head or a hard swelling of the tongue (woody tongue). This disease responds favourably to the intravenous administration of iodides.

SHIPPING FEVER

Shipping Fever is the most serious malady affecting stockers and feeders in Ontario. It is an infectious disease and gets its name from the fact that most outbreaks are associated with shipment through stockyards. It is common in feeder cattle a few days after they have arrived in the feed-lot.

The disease is characterized by loss of appetite, depression, weakness and high body temperature. Affected animals may show a discharge from the eyes and nose, cough frequently and, in the later stages, breathe with difficulty. Some cases have diarrhea. Death loss may be high, particularly if treatment is delayed.

When an outbreak occurs, all animals showing increased temperatures should be removed from the group and placed in dry, well-ventilated quarters. Warmth is desirable but less important than dryness and ventilation. A light diet, such as bran mashes with a little hay, is recommended. Treatment with sulfonamide drugs and antibiotics is generally successful if administered early.

Careful management during shipping can do much to prevent shipping fever. Before they are loaded, cattle should be well rested, fed hay and watered. Stock cars and trucks should be made as comfortable as possible by adequate bedding and by protection against draughts in cold weather. Feed and water should be provided en route during long journeys. When cattle are unloaded for feed and water, they should be given plenty of rest. Over-crowding should be avoided.

Most outbreaks of shipping fever occur immediately after the cattle arrive in the feed-lot and particular care should be taken at that time. Newly-arrived cattle should be given dry shelter and fed on hay. The water supply should be limited during the first day to about half their normal supply. No grain should be fed for about a week, and then only small quantities at a feed. If the cattle are to be placed on pasture, they should be allowed to graze only a few hours each day until they become accustomed to it. Any animal appearing abnormal should be isolated immediately and treated if necessary. New cattle should not be allowed to come in contact with cattle already on the farm for at least ten days.

Vaccination with bacterins a week or ten days before shipment or with serum immediately before shipment, in the stockyards, or on arrival in the feed-lot may also help to give immunity to the disease.

BLACKLEG

Blackleg is an infectious disease generally affecting cattle under two years of age at pasture, although occasional outbreaks occur among stabled cattle. The disease may reappear on the same farm annually since the organism which causes it can live in the soil for many years. Some districts in Ontario appear to be entirely free of it.

Blackleg kills quickly and, in most instances, the animal is found dead in the field. Dark swellings in the muscles containing gas are a common post mortem finding. Care should be taken to burn or bury deeply any carcasses thought to be infected with blackleg. Treatment of affected animals is seldom possible, although antibiotics may be effective if given early enough. Vaccination with a bacterin gives effective protection for up to a year and is recommended in areas where the disease exists.

FOOT-AND-MOUTH DISEASE

Until the 1952 outbreak, Foot-and-Mouth disease was of only passing interest to Canadian cattlemen. They now realize that "it can happen here" and that it can have a very serious effect on the whole live stock industry.

It is an extremely contagious virus disease which causes blisters and ulcers to form in the mouth and on the tongue, around the feet, and sometimes on the udder. It affects only cloven-footed animals. In most outbreaks, the death rate due to the disease itself is low, but there is a serious loss of flesh and milk, and permanent crippling is not infrequent. An unchecked outbreak soon becomes an epidemic. Since infection does not produce permanent immunity and vaccination protects for only a few months, there is no doubt that the continued existence of the disease in this country would, in itself, be equivalent to a tax of many millions of dollars annually on the live stock industry.

The policy adopted by this country and the United States is to contain an outbreak by an immediate and rigid quarantine, to slaughter all affected and exposed animals, with compensation to the owners, and to disinfect the infected premises. In this century, six outbreaks in the United States and one in Canada have been stamped out through the use of this method and there can be no doubt as to its effectiveness when rigorously applied. When a cattle owner observes symptoms suggestive of Foot-and-Mouth disease, he should inform his local veterinarian or nearest representative of the Health of Animals Branch, Canada Department of Agriculture, immediately.

FOOT ROT

Foot Rot is the commonest cause of lameness among cattle in Ontario. It occurs most frequently when cattle on pasture have access to mud holes or are forced to walk through mud to obtain drinking water. However, it may occur among cattle stabled under apparently excellent conditions. The disease is caused by infection penetrating the skin around the top of the hoof or between the claws. Open sores are formed when portions of skin slough away. Occasionally, infection invades the deeper structures and gets into one or more of the joints of the foot. These lesions heal with difficulty and may even cause the death of the animal.

Individual cases should be kept in a dry place and treated promptly. Some recover rapidly if the foot is kept clean and treated with mild antiseptics or healing oils. The injection of either soluble sulfonamide drugs into the blood stream or antibiotics into the muscle is the treatment preferred by most veterinarians.

If the disease becomes a herd problem, a trough containing a disinfectant solution, placed in such a position that the cattle are forced to walk through it once or twice a day, will keep down the number of new infections.

WARTS

Warts are unsightly growths which appear most frequently around the head and neck of young cattle or on the teats and udders of milking cows. They are mildly infectious and show some tendency to spread from animal to animal. Large warts may attain a weight of a pound or more and, if in an exposed place, may become so raw and painful as to interfere with growth and development.

Warts sometimes disappear without treatment after a few months. If they are numerous, their disappearance will be hastened by twisting or clipping a few off, painting the spot with tincture of iodine. and softening the remainder every three or four days with oil. In obstinate cases, veterinarians sometimes use a vaccine prepared from wart tissue.

PINK EYE (INFECTIOUS KERATITIS)

Pink Eye is a common infectious disease affecting the eyes of cattle. The first symptom noticed is an increased flow of tears which causes dirt to accumulate on the face around and below the eyes. The eyelids become inflamed and are kept partially closed. Frequently, the eyeballs become cloudy. Temporary blindness is common and, if ulcers form on the surface of the eyes, blindness may be permanent. Loss of life is rare but loss of condition and milk production may be serious. Pink Eye is seldom seen in the winter since most cases occur during the latter part of the pasture season.

The first step in handling an outbreak is to segregate the unaffected cattle in new pastures or barns. The affected cattle should be confined in a darkened barn. They should have access to water and be given plenty of succulent feed. Eye ointments containing antibiotics or sulfonamides may be helpful. Biologics cannot be depended upon to protect against the disease.

BLOAT

The term "bloat" refers to an excessive accumulation of gas in the paunch. Bloating is a common symptom of digestive upsets and may be due to a variety of causes. It can occur as a result of blockage of the gullet by an apple, potato or other similar object. Moderate bloating is not uncommon among steers on heavy feed. It occurs in its most dangerous form among cattle grazing on lush pasture, particularly when the sward contains a high proportion of legumes. Under these conditions, bloating may cause heavy death loss. Not all legume pastures cause bloat, and for reasons not completely understood. However, pastures either growing rapidly or wilted by drought after a period of quick growth appear to be especially dangerous. A deficiency of soil phosphorus may also be a factor.

When bloat is due to choke, the offending object should be removed as soon as possible. If the condition is prevalent among a group of animals on feed, it is generally advisable to cut down their intake of concentrates, at least temporarily. Bloat on pasture is the most difficult to treat since the gas is often mixed intimately with the content of the paunch. An ounce of turpentine or a half-ounce of formalin shaken up in a pint of milk and given as a drench may be helpful in simple cases. Drenching should be done slowly and carefully with the head no higher than horizontal. Placing a gag in the mouth, standing the animal with the front quarters elevated and kneading the paunch with the fist all help to expel gas. In severe cases, professional assistance should be obtained immediately.

Recognition of the following points may be helpful in preventing bloat:

1. Mixtures of grasses with legumes cause much less bloat than legumes alone. Practical tests show that serious bloat rarely occurs if grasses make up at least 50 per cent of the mixture.
2. Supplemental feeding of hay in drylot at night will reduce the incidence of bloat on legume pasture. Feeding hay at pasture may also help.
3. Grass pasture at night will help to prevent bloat on legume pasture the next day.

URINARY STONES

Urinary stones occur most frequently in steers on heavy feed, although occasionally bulls are affected. Symptoms appear when the stones which are formed in the bladder pass out along the urinary passage, blocking the flow of urine. The main signs shown by the animal are more or less constant pain and frequent attempts to urinate. If the condition is not relieved, the bladder will rupture in about forty-eight hours. This gives temporary relief but the animal will gradually be poisoned by its own waste products. Following rupture of the bladder, death generally occurs within a day or two.

The cause of the condition is not well understood. However, it occurs most frequently when there is a gross imbalance between calcium and phosphorus in the diet. Heavy deposits of lime salts in the drinking water may help to create this imbalance. In addition, heavy feeding, lack of exercise and limitation of the drinking water may act as contributing causes.

Most cases require surgical treatment. It is seldom practicable to remove the stone but the bladder can be allowed to drain through an artificial opening. As a rule, animals which have been operated on in this manner should be marketed as soon as possible.

CALF SCOURS

Diarrhea in pail-fed calves is largely a result of feeding errors, such as feeding too much milk or feeding milk from dirty pails. Strict attention to such details is necessary before the condition can be corrected. When uncomplicated cases occur, it is good practice to administer an ounce or two of castor oil, omit a feed of milk and restore the calf to full feed gradually over a period of several days.

Occasionally, outbreaks of infectious scours occur which may result in a high mortality. The calves are born apparently in good health but become ill during their first week. Scouring is usually a symptom although some calves may die without scouring. Death may occur within a few hours or the calf may last several days. Few untreated cases recover.

On farms where this disease exists, it is particularly important to have the calf born in a disinfected pen or at pasture. In addition, dosing with appropriate sulfonamide drugs or antibiotics, started immediately after birth and continued for four or five days, will help to prevent the disease. Attention to the nutrition of the dam, with particular reference to vitamin A, may help to build resistance to scours in the newborn calf.

CALF PNEUMONIA

Pneumonia (inflammation of the lungs) is one of the common reasons for death loss among calves. While bacteria or viruses play a part, its primary cause is generally thought to be inadequate stabling facilities, particularly dampness and poor ventilation. It may be caused also by careless drenching which causes medicinal material to pass down the windpipe into the lungs. Some cases occur as a sequel to prolonged scours.

As a rule, the age group principally affected is from one month to three or four months. The most evident symptoms are high temperature, discharge from the nostrils and rapid, laboured breathing. Until sulfonamide and antibiotic therapy became available, the death rate was high among affected calves. Now, early treatment saves the majority, although cases which become chronic usually prove fatal.

Since the disease tends to spread, affected calves should be segregated immediately. It is advisable to separate the remaining calves into smaller groups as a means of avoiding overcrowding and further spread of the infection. Bacterins are of uncertain value. Probably the most important factor in preventing calf pneumonia is to provide proper ventilation which thus minimizes dampness and draughts.

ABORTION

No disease causes greater financial loss to beef cattle breeders in Ontario than does contagious abortion, (Brucellosis) despite the fact that it can be effectively counteracted by vaccination. The saleable product of a beef cow is her calf and its loss means that she produces no income for a year or more. Symptoms of infection include premature calving, retention of the afterbirth and subsequent sterility. Although the organisms usually localize in the udder or womb, on occasions they affect the joints, especially the knee and stifle. The site of infection in bulls is usually the genital organs.

A positive diagnosis of brucellosis in a breeding herd may be established by having blood samples tested in a laboratory. While occasional early infections are missed by this test, it is, in general, a reliable method of determining whether the infection exists in a herd or in an individual animal.

This disease is frequently brought into clean herds by the introduction of one or more infected animals. It is spread within the herd by the discharges of infected cows contaminating pasture or feedstuffs of other cattle. An infected bull may also spread the disease at the time of service.

Most control programs are based on calfhood vaccination. Vaccination of calves between six and nine months of age produces a serviceable immunity. The vaccination program is operated jointly by the Federal and Provincial governments and vaccination service can be obtained through practising veterinarians.

It must be remembered that brucellosis is not the only cause of abortion in cattle. *Trichomoniasis*, caused by a microscopic parasite, is spread by the bull at the time of service and causes abortion and sterility. Similar symptoms are produced by *vibrio foetus* infection. In both of these infections, abortions tend to occur at an early stage and may be missed by the owner. Where widespread sterility exists in a herd, along with occasional abortions, the condition should be thoroughly investigated since it may be the result of one or more of a number of causes.

BREEDING PROBLEMS

Sterility or delayed breeding is a problem of increasing concern to beef cattle producers. It is a complex problem arising from many causes and not, therefore, capable of quick solution. It is a permanent problem and requires a permanent program to combat it.

Suggested measures for improving breeding efficiency in the beef herd are as follows:

1. Keep accurate and complete records of dates of heat, breeding, calving or abortion, and unusual symptoms. Such records are of great value in arriving at a diagnosis in case of trouble.
2. Give cows a rest of at least sixty days after calving before breeding.
3. Do not breed a cow showing an unnatural discharge.
4. Isolate aborting cows until all discharge has ceased.
5. Consult a veterinarian if a cow does not conceive following three services to a fertile bull.
6. Have the breeding health of valuable herds checked at regular intervals by a qualified person. Regular pregnancy diagnosis is an important part of such a service.
7. Do not discard a cow because of sterility before having her examined for pregnancy.
8. Be sure to check the herd sire if infertility is widespread in the herd.

PARASITIC DISEASES

The majority of cattle parasites in Ontario may be readily kept under control by sound farm management practices, proper sanitation and regularly applied preventive treatments.

The most serious parasites with which the dairyman has to contend are the warble flies and their grubs. These insects, if neglected, will cause loss of weight through making animals gad and their grubs may do extensive damage to carcasses and hides. The control of warbles, however, is well organized in the Province and is conducted on a community basis in many townships which, upon petition of two-thirds of the cattle owners, have passed by-laws requiring all cattle to be treated in accordance with the Warble Fly Control Act. In other areas not under the Act, they are treated individually as recommended in the regulations made under the Act. The hand-dressing consists of a one-pound cube of derris containing 5 per cent rotenone or its equivalent to one gallon of water. It is applied with a stiff brush to the backs of cattle in April and May.

"Barn itch" may unnecessarily cause unthriftiness in herds, especially during the winter months. This condition is commonly caused by lice and, at other times, by ringworm or mange mites, either alone or collectively. Regular inspections of animals and the routine use of standard dusting powders for lice will keep herds free from these pests. Suspected cases of mange should be reported immediately to local representatives of the Health of Animals Branch, Canada Department of Agriculture, who will ensure that action is taken to prevent the spread of this disease.

Internal parasites (including worms, coccidia and other protozoans), although they do become established in certain herds, are relatively innocuous in Ontario. High standards of sanitation, ample pastures, manger feeding and the use of properly constructed watering troughs will do much to keep the disease caused by these parasites under control. Young animals, as often as possible, should be segregated from older stock.

During the pasture season, milking cows are more productive and young stock make better gains when they are given shelter or protection against flies. Horn flies may be controlled effectively with methoxychlor sprays, and other flies, to a certain degree, with standard live stock fly sprays, when it is practical to apply them.

RINGWORM

Ringworm is the most common skin disease affecting beef cattle in Ontario. It is an infectious disease caused by a parasitic fungus. Young cattle appear to be most susceptible although older cattle and even other species may be affected. The disease is transmissible to man by contact and this should be kept in mind in handling affected animals. Overcrowding in dark pens favours its spread but it may be found under excellent sanitary conditions, and even, occasionally, among pastured cattle.

Typically the disease appears as crusty gray patches, up to an inch and a half across, in the region of the head and neck, particularly around the eyes. In severe cases the patches may join together to form large areas and be found on almost any part of the body. The lesions are unsightly, cause weight loss due to discomfort and represent a constant danger of infection to human contacts.

As a first step in controlling the disease it is recommended that, whenever practicable, affected animals be segregated and their pens or stalls be cleaned and disinfected. Clean cattle which have been in contact with the disease should be watched closely for the appearance of lesions and treated promptly.

Best results in treatment follow soaking the lesions with oil for a few hours to facilitate removal of the crust, followed by direct daily application of tincture of iodine, sulfur ointment or other antiseptic treatment. When large numbers are involved washes or sprays may be used to advantage. Some forms are resistant to ordinary treatment. In such cases professional assistance should be obtained.

MARKETING

CATTLE CYCLES

The cattle population of Canada is never static—it tends to move in one direction for a number of years; then the trend is suddenly reversed and the movement is in the other direction for almost the same number of years. The period of time that elapses between one low point in the cattle population and the next is commonly referred to as a "cycle".

As a general rule, when the cattle population is increasing, marketings are relatively low on account of female stock being held back for breeding purposes and prices tend to strengthen. On the other hand, when the cattle population is declining, marketings are heavy and prices reflect an easier tone.

Although this rule is not infallible, it does appear to work in the majority of cases. Consequently, the information gleaned from a study of the cattle population statistics proves helpful in forecasting future trends, both with respect to marketings and price.

FACTORS AFFECTING CATTLE PRICES

Throughout the present century, Canada has been a surplus producer of cattle. Consequently, cattle prices have been determined on the basis of the returns obtained for that portion of the cattle or beef which was sold outside this country. The United States has been our most lucrative market, except in the early thirties when the American tariff proved to be an insurmountable barrier, in the period 1942-1948 when all beef that could be spared was being requisitioned for shipment to Britain, and in 1952 when the American government imposed an embargo against Canadian cattle and beef on account of the presence of Foot-and-Mouth disease in this country.

During the years when shipments were being made, annual exports ranged from a few thousand head or the equivalent to approximately 400,000 head. On January 1, 1955, a reciprocal agreement between Canada and United States was in effect under which duties were established at the following rates:

(a) Calves under 200 pounds	1½c per pound
(b) Cattle 200 to 699 pounds	2½c per pound
(c) Cattle 700 pounds and over	1½c per pound
(d) Beef and Veal	3c per pound

N.B. A quota of 400,000 head applies in the case of cattle 700 pounds and over. Once this figure is exceeded, the duty is increased to 2½c per pound.

Whenever cattle prices in one country tend to get out of line with those in the other country, cattle or beef start moving towards the country which offers the more attractive market. As long as the present agreement is in effect, and barring the outbreak of a serious contagious disease in either country, prices are likely to be influenced by:

(a) the supplies of cattle available in the two countries and, more particularly, the number that are being currently marketed,

(b) the demand, a condition which is usually influenced by the expendible income of the Canadian and American people, and

(c) the prices of other classes of meat which compete with beef for a share of the consumer's meat dollar.

MEAT CONSUMPTION

Beef and pork combine to constitute about 85 per cent of the meat consumed by Canadians. During the years 1947 to 1954, the per capita consumption of these two classes of meat were as follows:

Year	Beef Lbs.	Pork Lbs.
1947	67.2	51.9
1948	57.5	53.9
1949	56.5	59.2
1950	50.3	60.8
1951	44.1	67.8
1952	44.7	65.9
1953	59.1	57.0
1954*	65.0	56.0

*Preliminary estimate.

Price has been the greatest single factor in determining the meat buying habits of the Canadian consumer. When beef prices are high in relation to pork, the consumption of beef declines and that of pork increases and vice versa.

This characteristic of Canadian consumers tends to keep prices in balance. As a result, the term "relationship between live stock prices" has been coined. This simply means the relationship between the price per hundredweight of live cattle and live hogs, less any government premiums that might be paid. The long time average, that is, the average established between 1914 and 1941, is 75.7; hence, on the average, the price of cattle has been 75.7 per cent of the hog price. Any time prices tend to deviate sharply from that relationship, there is likely to be an increase in the demand for the class of meat which is being offered at the more attractive price. Eventually, the class of meat which is priced at the higher figure will have to be offered at a lower price in order to stimulate demand. This, in turn, will be reflected in lower prices for the live animals. So, in the final analysis, competition within the industry is a powerful factor in determining price.

MONTHLY TREND IN MARKETINGS

Cattle may be marketed at any time regardless of the degree of finish which they may be carrying. If the cattle are young and underfinished, they will probably be bought for further feeding; if old and extremely thin, the meat is boned out following slaughter and used in the manufacture of bologna and other processed meats; but, if the cattle are fat or are carrying a degree of finish only slightly below the optimum, they will find a ready sale for slaughter purposes.

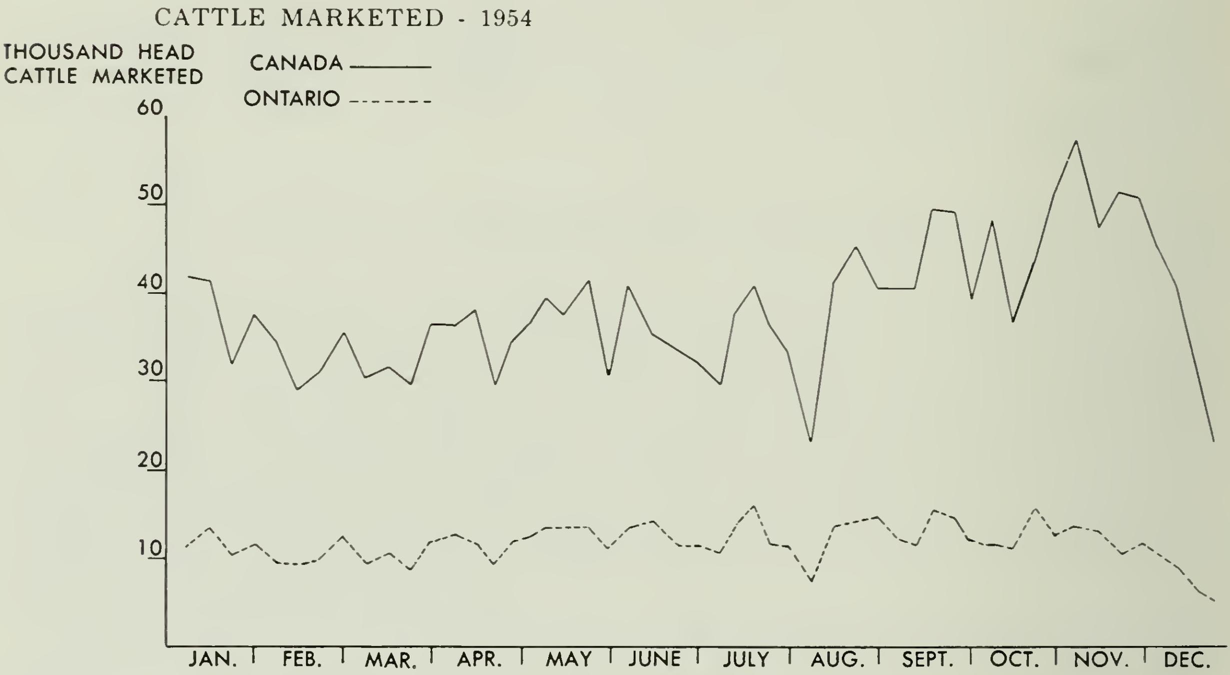
In view of the fact that there are buyers for all grades and classes of cattle, it is impossible to predict the number that may be offered in any week or any month. The factors which influence owners in their decisions with respect to the time of marketings are as follows:

(a) The need for cash. As a general rule, beef producers do not have a regular weekly or monthly income as is the case with dairymen. Hence, it becomes necessary from time to time either to borrow money or to sell cattle in order to pay current expenses. Some farmers dislike borrowing; so, in many instances, market their cattle earlier than intended.

(b) The shortage of feed. Some farmers sell cattle before they are properly finished in preference to buying the feed which might be necessary to qualify them for a higher grade, even though such action might enhance their value by two or three cents per pound.

(c) Habit. The majority of beef producers follow the same routine year after year. They plan to have their cattle finished at a particular time and, regardless of how many tempting offers are received, the cattle are not sold until the usual time which has been predetermined well in advance. Similarly, dairymen, by force of habit, usually cull their herds at the end of the pasture season, thereby helping to swell the heavy fall marketings.

The following graph reveals the number of cattle marketed during each week of 1954 in Canada and in Ontario:



It will be noted that (a) cattle marketings fluctuated from week to week; (b) the fluctuations were more pronounced in Canada than in Ontario; (c) cattle marketings were lowest in August and highest in November; and (d) Ontario marketings accounted for approximately 30 per cent of the cattle marketed in Canada in 1954.

METHODS OF SELLING CATTLE

Although Ontario beef producers may exercise a great many options in the selling of their cattle, the following methods are used most frequently:

(a) Cattle may be sold to a drover or live stock buyer, of which there are still quite a number in Ontario. These men will buy cattle at an agreed upon price per head or per pound. When the cattle are sold on the per pound basis, the buyer and seller invariably agree upon the location at which the weighing will take place. Since very few farmers have suitable scales, this is usually done at some convenient public scales or at the stock yards.

(b) Cattle may be consigned to a commission merchant operating on the Ontario Stock Yards. When cattle are consigned in this manner, every buyer on the market has an opporunity of bidding on them and they are sold to the highest bidder.

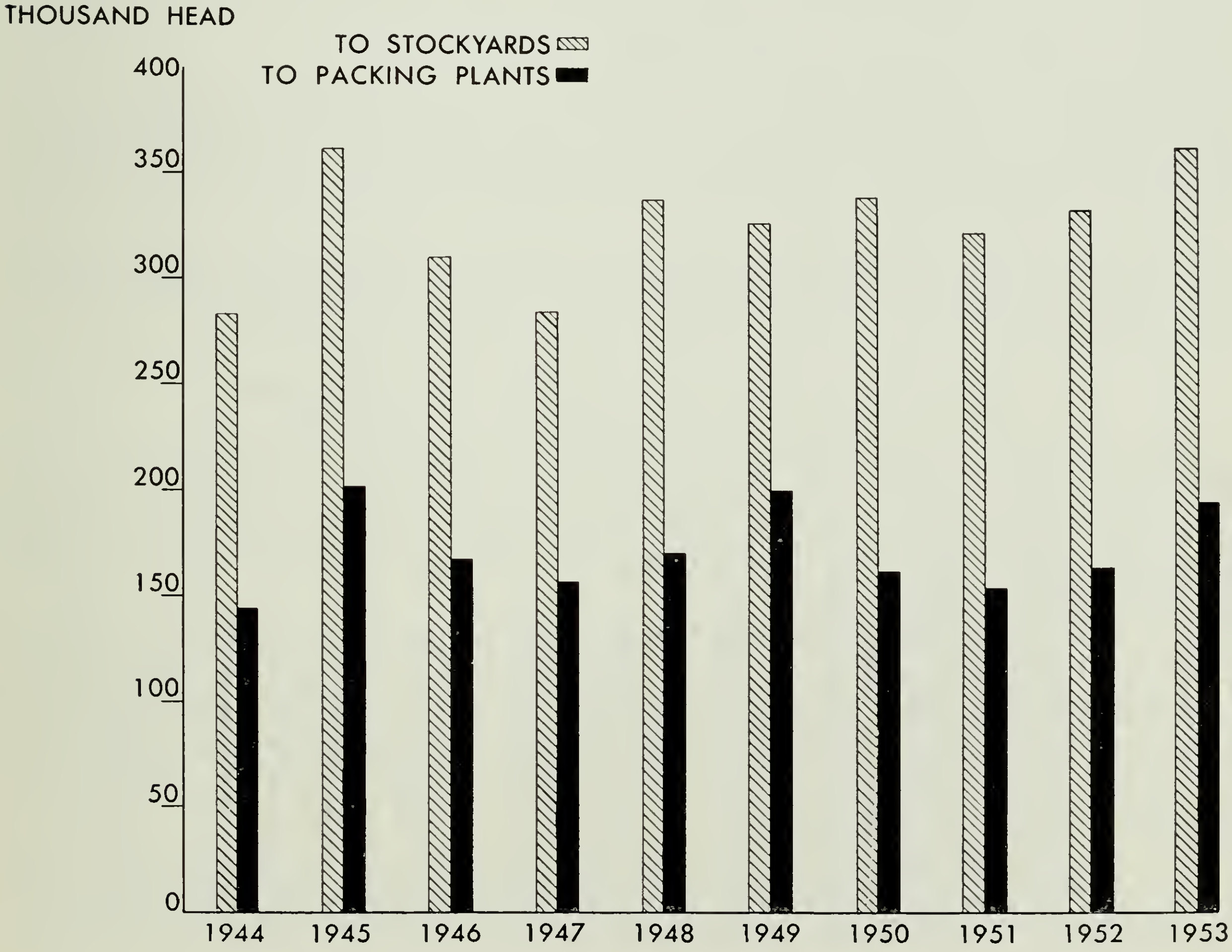
(c) Cattle may be sold direct to packers. In order to avoid stock yard and commission charges, some farmers insist on negotiating the sale of their own cattle. In instances where farmers have large numbers of cattle, packer buyers may be willing to visit the farms and make offers on them. Usually, these sales are made on the basis of an agreed upon price per pound with the weight to be determined at the local shipping station or when the cattle are unloaded at the packing plant. In a few cases, sales are made on the basis of dressed weight and grade.

(d) Cattle may be marketed at community sales where they are sold at auction with the consignor receiving the selling price, less a commission charge. Very few finished cattle are offered at such sales, the consignments consisting largely of calves, breeding cows, old cows and feeder cattle. Most of the slaughter stock is purchased by traders who dispose of it either direct to packers or on public stock yards.

(e) Cattle may be sold to local butchers who may be interested in purchasing a few head per week for slaughter and resale through their stores. This does not create a very large market for cattle but it may provide a few producers with a profitable outlet, particularly if they are prepared to spread their marketings over several weeks.

Regardless of the method by which cattle are sold, the great majority eventually arrive at the Ontario Stock Yards or are delivered direct to packing plants. The following graph shows the number marketed through each channel during the years 1944 to 1953 inclusive:

ONTARIO CATTLE DELIVERIES



FUNCTION OF STOCK YARDS

In Ontario, there is one public market for cattle—the Ontario Stock Yards, which is owned by the Ontario Government, and whose affairs are administered by the Ontario Stock Yards Board. It is located in the western part of Toronto, adjacent to two large and several medium sized packing plants. There are two public stock yards in Montreal which are utilized by Ontario farmers, particularly those residing in the eastern part of the Province.

A stock yard consists of pens—usually covered, where live stock can be assembled and offered for sale. The management of the stock yard simply provides the facilities—it does not engage in the business of buying or selling. A producer may utilize these facilities to sell his own cattle. Even so, most producers engage the services of a commission merchant.

When cattle are shipped by rail to the Ontario Stock Yards, yard employees are responsible for unloading and delivering them to pens that have been allocated to the commission firm to which they have been consigned. Once the cattle are placed in the assigned pens, the gates are locked and, except in unusual cases, they are not removed until they are sold. Only employees of the stock yards company and the commission merchant have access to the pens.

When the cattle are sold, they are driven to the scales by an employee of the commission merchant. The weighing is done by an employee of the stock yards, who is a neutral man, being neither the agent of the producer nor of the buyer. All weights are printed on special tickets and the weights which appear on those tickets are the official weights for settlement purposes.

After the cattle have been weighed, a yard employee drives them to a pen which has been allotted to the buyer. However, the cattle still remain the responsibility of the stock yards company until they have been counted out of the pen and until the buyer has signed a release.

The stock yards company furnishes bedding, and persons using the facilities may purchase hay if they wish to feed their cattle before offering them for sale, or if they wish to hold them for a few days in anticipation of a rise in the general price level.

The stock yards company makes a charge for the use of its facilities and for services rendered. The present schedule of rates is as follows: 50 cents per head for cattle delivered by rail and 55 cents per head for cattle delivered by truck.

FUNCTIONS OF COMMISSION MERCHANTS

Commission merchants conduct business on the Ontario Stock Yards under the provisions of the Live Stock and Live Stock Products Act. This Act requires that each commission merchant conduct his business in an ethical manner and that he be bonded in such amount as may be deemed necessary to protect his clients against financial loss.

Commission merchants operating on the Ontario Stock Yards are organized into a body known as the Toronto Live Stock Exchange. This body deals with such matters as determining the charges for services rendered, establishment of a code of ethics and disciplinary action against members who fail to abide by the rules of the Exchange. All charges proposed by the Exchange must be approved by the Stock Yards Board.

Commission merchants are generally considered to be the agents of the producers. As such, they are expected to sell cattle consigned to them to the highest bidder and return to the producer the full selling price, less the selling charges which will include yardage fees and may include transportation charges if the producer indicates that such charges should be deducted and remitted to the agency which furnished the transportation.

Commission merchants may serve producers in another way—they may act on their behalf in buying cattle. For example, a farmer may place an order to buy cattle with a commission merchant. In doing so, he will probably state the class and weight of cattle wanted and the maximum price that he is willing to pay. In this case, he expects the commission merchant to fill the order with the best available cattle at the lowest possible price. The commission merchant is not permitted to fill such orders with cattle which have been consigned to him unless suitable cattle cannot be obtained from other commission merchants.

A commission merchant may also act as agent for a packer or processor. For example, a Montreal packer may order a carload of cattle through a Toronto merchant—possibly because of a shortage of a particular class of cattle on the Montreal market. As in the previous case, he must, if possible, fill this order with cattle purchased from another commission merchant.

Commission charges in effect on January 1, 1955 were as follows:

(a) On carlot shipments—$1.25 per head with a maximum of $25.00 per carload containing up to 25 head; 70 cents per head for each additional animal, providing that, in no case, shall the commission charge exceed $35.00 per carload.

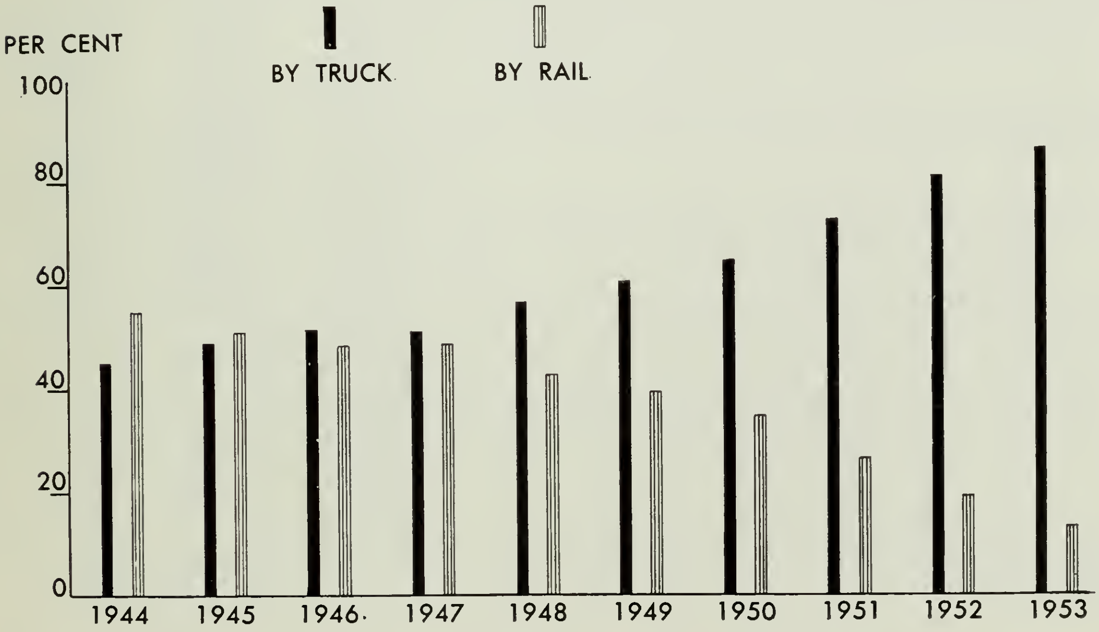
(b) On truck shipments—$1.50 per head.

N.B.—On truck shipments, employees of the commission merchant take delivery of the cattle at the unloading platform and are responsible for driving them to the pens.

TRANSPORTATION

Inasmuch as cattle must eventually be moved from the area of production to the market or packing plant, transportation plays an important role in the process of marketing. The following graph indicates the trend which took place in transportation between the years 1944 and 1953 inclusive:

MOVEMENT OF ONTARIO CATTLE TO STOCKYARDS AND PACKING PLANTS



Regardless of the method of transportation, cattle will lose weight in transit. This loss of weight is commonly referred to as shrink. The shrink will vary according to the amount of fill that the cattle have at the time of loading, the degree of finish which they are carrying and the distance travelled. Cattle that have been given a heavy feed and a lot to drink before being loaded will shrink more than cattle that have received a moderate amount of feed. In addition, cattle that have been fed heavily are more likely to suffer ill effects from travelling. Usually, cattle that are well finished do not shrink as much as cattle that are in fair condition and cattle that have been stable finished shrink less than cattle that have been finished on grass.

While distance travelled is a factor, it is not as important as the two mentioned above. According to test conducted in the United States, cattle that were trucked over a distance of 200 miles experienced 46.4 per cent of their total shrink in the first 25 miles, 18.5 per cent in the next 25 miles, 19.6 per cent when between 50 and 100 miles from home, and only 15.6 per cent during the last 100 miles.

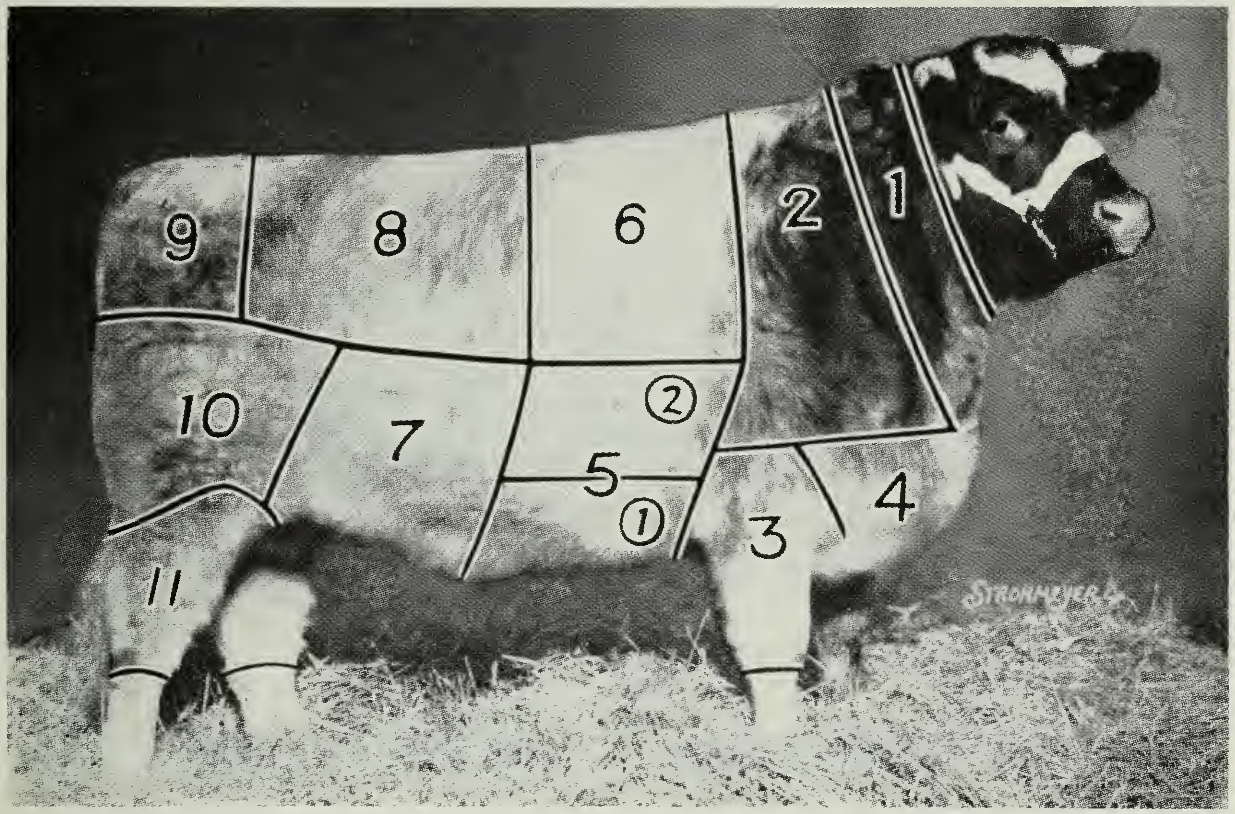
As a general rule, cattle will recover most of this shrink if allowed to eat and drink their fill upon being delivered to the market. Theoretically, the seller is well paid for the feed. However, it is quite possible that the buyer is alert to the fact that the cattle have been fed and watered and he makes his bids accordingly. Even so, cattle which have been fed and watered can be displayed to better advantage provided, of course, that they have not taken on a bloated appearance and, as a result, should sell more readily and at relatively higher prices.

MARKET GRADES OF CATTLE

There are no official grades of live cattle in Canada. However, after years of common usage, certain terms have become firmly fixed in the minds of those persons who operate on the market. The terms used to classify cattle and the number in each class in 1954 were as follows:

Class	Sub class	No. Marketed	Per Cent of Total
Steers (up to 1,000 pounds)	choice	9,283	1.72
"	good	24,381	4.52
"	medium	26,137	4.84
"	common	23,194	4.30
Steers (over 1,000 pounds)	choice	62,975	11.67
"	good	49,125	9.10
"	medium	25,692	4.76
"	common	9,468	1.75
Heifers	choice	1,331	0.25
"	good	31,062	5.76
"	medium	34,956	6.48
"	common	23,851	4.42
Fed Calves (baby beeves)	choice	59,961	11.12
"	good		
"	medium		
Cows	good	134,340	24.89
"	medium		
"	common		
Bulls	good	23,800	4.42
"	common		
Total slaughter cattle		539,556	100.00

The marketing service of the Canada Department of Agriculture maintains a staff at all public stock yards. One of the functions of this staff is to compile data with respect to daily marketings. The information collected at each yard is forwarded to Ottawa where it is used for preparing the Live Stock and Meat Trade Report, a publication which is issued weekly. The cattle sold on each stock yard are classified by members of the staff of the marketing service largely on the basis of the prices at which they were sold. In other words, the classification, except for such obvious characteristics as sex and stage of maturity, is determined by selling price rather than by any sorting or grading process.



Steer taped to show the location of the various wholesale cuts of beef. 1. Neck 2. Chuck 3. Fore shank 4. Brisket 5. Plate 6. Rib 7. Flank 8. Loin 9. Rump 10. Round 11. Hind Shank

BEEF GRADES

Grades for beef have been established under the Live Stock and Live Stock Products Act as follows:

(a) Grade A (red brand). This grade includes only choice carcasses of steers and heifers having excellent conformation, finish and quality.

(b) Grade B (blue brand). This grade includes only good carcasses of steers and heifers having good conformation, finish and quality.

(c) Grade C (commercial). This grade includes only carcasses of steers, heifers and cows which show indication of youth and which are below the standard of A and B grades.

(d) Grade D—class 1. This grade includes only the carcasses of steers and heifers which are rangy, angular, irregular in conformation and thinly fleshed.

Grade D—class 2. This grade includes only carcasses of cows not eligible for class 2, but above "canner and cutter" quality.

(e) Grade M (manufacturing). This grade includes only carcasses of steers, heifers and cows below the standards prescribed for Grade D and, for the most part, includes beef not suitable for sale as carcasses.

(f) Grade S. This grade includes only the carcasses of stags and bulls.

The beef is graded when cattle are slaughtered in inspected plants by inspectors in the employ of the Marketing Service, Canada Department of Agriculture. All carcasses which meet the standards of Grade A are stamped with the letter A, and all carcasses which meet the standards of Grade B are stamped with the letter B. No stamp marks are placed on carcasses of the other grades unless they are requested by the trade. Carcasses bearing the stamp of the Federal Inspector may be ribbon branded by packing plant employees—Grade A with Red Ribbon brands, and Grade B with Blue Ribbon brands. When Grade C beef is ribbon branded, brown ink is used. These brands are applied to a carcass in such a manner as to be legible on the exterior surface of every retail cut.

The grading of beef is not compulsory but, if beef is graded, it must be classified and branded in accordance with the grades and markings described heretofore. Most retailers who merchandise Grade A or Grade B beef prefer to have it branded. Branding gives it a stamp of approval; hence, most of the beef which qualifies for the two top grades bears a ribbon brand to denote its grade.

In 1954 the beef graded in Ontario was classified as follows:

Grade	No. of Carcasses	Percentage of Total
A	99,194	17.50
B	126,693	22.35
C	156,165	27.55
D1	40,535	7.15
D2	46,190	8.15
D3	34,350	6.06
M	46,426	8.19
S	17,257	3.05
Total	566,810	100.00

WHEN SHOULD CATTLE BE MARKETED?

The following graph shows the average prices paid on the Ontario Stock Yards for cattle of several grades during each week of 1954:

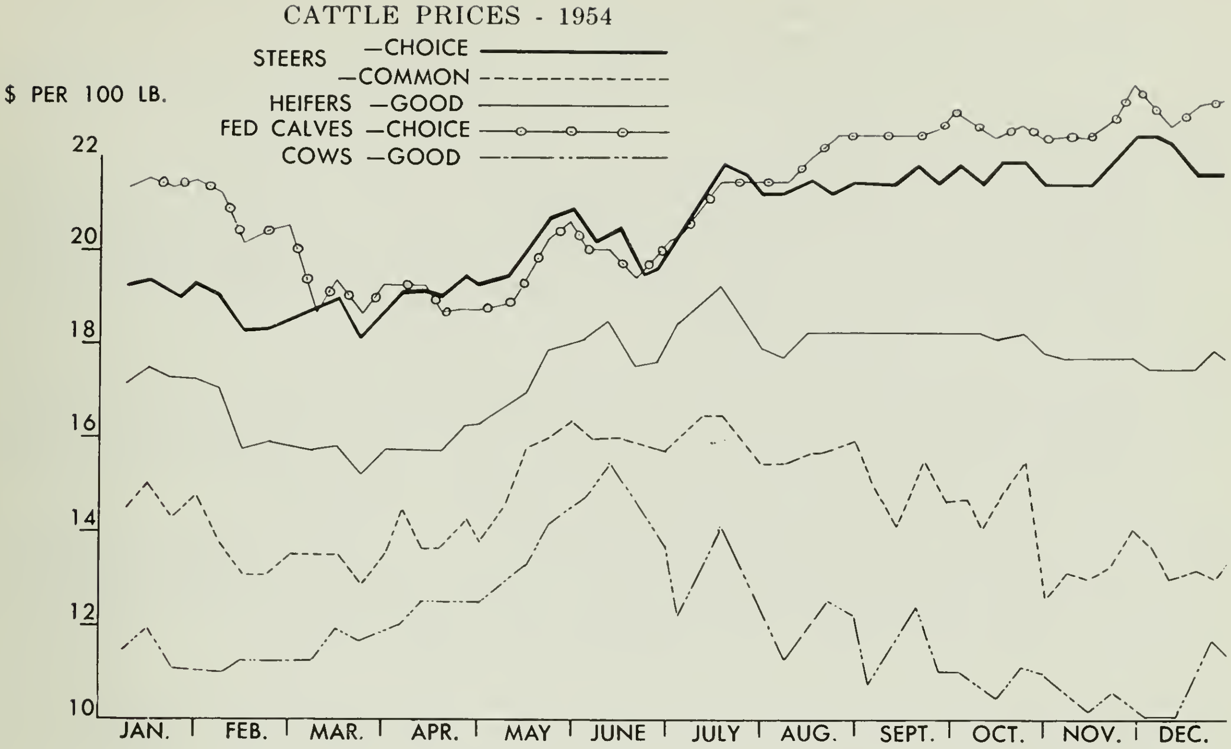
It will be noted that,

(a) the prices at which most grades of cattle sold fluctuated from week to week and from month to month;

(b) the prices at which choice steers sold remained fairly constant throughout the year, indicating that there was a steady and ready demand for cattle of this class;

(c) cattle prices showed a tendency to advance between January and June; then the prices of all grades, except choice steers and fed calves, began to register a downward trend which continued until the end of the year;

(d) the margin in price between choice steers and common steers was quite wide throughout the year but was greatest during the fall months;



(e) fed calves sold for higher prices than choice steers during all months of the year except April, May and June, the months when marketings of fed calves reached their peak;

(f) cow prices were fairly high in June, a month of light marketings, and were relatively low in the fall, the season when breeding herds are culled; and

(g) choice steers commanded relatively high prices by comparison with those obtained for good heifers.

The graph provides some clues with regard to practices which might be adopted in obtaining maximum returns. The following examples are worthy of consideration:

(a) The margin between choice and common steers is great enough to provide the incentive for finishing steers with a view to having them qualify for their highest possible grade. The extra two, three and, in some months, four cents per pound amounts to an additional twenty to forty dollars per head.

(b) Heifers invariably sell at lower prices than steers—probably because of their tendency to become patchy and uneven in their fleshing and also because of their lower dressing percentage. The discount is not so great when heifers are finished and marketed as baby beeves. It may not be convenient for every producer to market his heifers in this manner; if not, he should make an effort to have them finished and marketed before they weigh 1,000 pounds.

(c) Cow marketings are heaviest and cow prices are lowest in the fall months. If a few farmers would advance the time for conducting their culling operations, higher returns from the sale of cows might be obtained.

(d) When fed calves are marketed in April, May and early June, they are being sold in competition with Ontario's best stable fed cattle, and hence, seldom command any appreciable premium then. Increased returns are more likely to be obtained if such calves are marketed at times of the year when smaller quantities of choice beef are available.

Certain other factors which influence returns, but which are not shown in the graph, are as follows:

(a) There is a very limited market in Canada for heavy cattle, that is, cattle weighing over 1,200 pounds. On occasions, the American demand is keen enough to provide a profitable outlet for cattle in this weight range. Since that outlet is far from dependable, producers are well advised to market their cattle at lighter weights.

(b) Canadians appear to be developing an antipathy for fat meat. Such being the case, there is no object in fattening steers beyond the optimum degree of finish. To do otherwise simply adds to the cost of production and detracts from rather than enhances the value of the animal.

(c) The demand for beef declines rather sharply at the time of religious holidays and during periods of extremely hot weather. Hence, producers should be wary about marketing cattle at those particular times.